

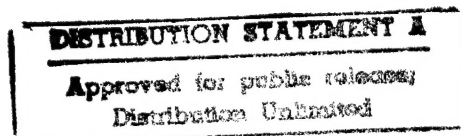
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JPRS-UMS-86-005

25 APRIL 1986

# USSR Report

MATERIALS SCIENCE AND METALLURGY



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## ANALYSIS AND TESTING

UDC 612.82:620.1

### PROBLEM OF HYSTERESIS PROPERTIES OF HUMAN SKELETAL MUSCLES

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 4, Jul-Aug 85  
(manuscript received 5 Jun 84) pp 743-746

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[Abstract] The biceps, a skeletal muscle accessible for contact with a circular die pressed into the muscle under known force, was studied. The variation in impression depth as a function of the force applied to it was recorded. The maximum impression depth was 12 mm for a flaccid muscle under a load of 4.9 N. The deformation-load characteristics was recorded with various degrees of muscular tension achieved by requiring the subject to hold weights of various masses in an isometric regimen. A comparison of the results of analysis of the Calvin-Voigt model, namely, the character of the change of the slope of its curve of the area of the hysteresis loop and of residual deformation, with the result of the experimental study of the elastic-viscous properties of human skeletal muscle indicates that it is quite suitable for interpretation of deformation-load characteristics.

References 4: all Russian.

[53-6508]

UDC 621.315.592

### PHASE TRANSITIONS IN $\text{CdIn}_2\text{S}_4$ AND $\text{CdGa}_2\text{S}_4$ SINGLE CRYSTALS ANNEALED IN MELTED CADMIUM

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 21, No 9, Sep 85  
(manuscript received 27 Jul 83) pp 1457-1461

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[Abstract] Results are presented from a study of photoluminescence spectra and the composition of single crystals of  $\text{CdIn}_2\text{S}_4$  and  $\text{CdGa}_2\text{S}_4$ , some of which were annealed in a cadmium melt. The properties of the annealed crystals

were studied both on the surface and in the volume of the crystals, by removal of a 1-1.5 mm surface layer and chemical etching of the deeper layer thus uncovered. Photoluminescence was excited by wavelengths of 313 and 365 nm produced by a mercury vapor lamp. It is found that annealing the crystals in the cadmium melt at 1020 K for about 20 hours causes decomposition of the compounds into CdS containing the element of the third group as an impurity and In or Ga, present as inclusions. The CdS formed is polycrystalline and has a resistivity of approximately  $10-10^2$  ohm·cm. Decreasing annealing time results in the appearance of CdS only on the surface, with the  $\text{CdIn}_2\text{S}_4$  or  $\text{CdGa}_2\text{S}_4$  ternary compound still present within the volume of the specimens. References 8: 5 Russian, 3 Western.  
[48-6508]

UDC 541-67,661.868/868

DEVIATION FROM STOICHIOMETRY AND CERTAIN PHYSICAL PROPERTIES OF  $\text{HgCr}_2\text{Se}_4$   
MAGNETIC SEMICONDUCTOR

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 21, No 9, Sep 85  
(manuscript received 10 Jan 84) pp 1468-1471

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[Abstract] The area of homogeneity of  $\text{HgCr}_2\text{Se}_4$  was determined by roentgenographic analysis of polycrystalline specimens obtained in evacuated quartz ampules at 820-920 K over a period of 5-8 days. Most of the experiments were performed at 920 K, the time required to reach phase equilibrium increasing with decreasing temperature. The phase relationship, spinel phase unit cell parameter, and Curie point were determined as functions of composition of the specimens. It was found that a chromium-chalcogenide spinel has a narrow area of homogeneity and composition  $\text{Hg}_{0.9}\text{Cr}_2\text{Se}_{3.82}$  with significant deviation from stoichiometry. The solubility of the elements In, Ag, and Cl in  $\text{HgCr}_2\text{Se}_4$  was studied; In primarily replaces ions in the B-sublattice, while Ag replaces ions in the A-sublattice up to about 1 at.%. The solubility of Cl in the spinel is very slight. References 10: 5 Russian, 5 Western.  
[48-6508]

## THE SYSTEM Yb-Sb-Te

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 21, No 9, Sep 85  
(manuscript received 16 Jan 84) pp 1479-1482

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[Abstract] A study is made of the ternary system Yb-Sb-Te in the cross-sections  $\text{Yb}_4\text{Sb}_3\text{-Sb}_2\text{Te}_3$ ;  $\text{Sb}_2\text{Te}_3\text{-Yb}$ ;  $\text{YbSb}_4\text{Te}_7\text{-Te}$ ;  $\text{YbSb}_4\text{Te}_7\text{-Yb}$ . The physical-chemical studies are used as the basis for production of a projection of the liquidus surface of the ternary system. Two ternary compounds are found,  $\text{YbSb}_2\text{Te}_4$  and  $\text{YbSb}_4\text{Te}_7$ , as well as areas of  $\text{Sb}_2\text{Te}_3$ -based solid solutions. It is found that  $\text{YbSb}_2\text{Te}_4$  has a polymorphous transformation. References 5: 4 Russian, 1 Western.  
[48-6508]

UDC 541.123.3

THE SYSTEM Sb-Sb<sub>2</sub>Se<sub>3</sub>-SbI<sub>3</sub>

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 21, No 9, Sep 85  
(manuscript received 2 Jan 84) pp 1483-1485

CHERVENYUK, G.I., BELOTSKIY, D.P., BABYUK, P.F. and LEGETA, L.V.,  
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[Abstract] Results are presented from thermal and microstructural analyses of alloys in the cross-section  $\text{Sb}_{0.8}\text{Se}_{0.2}\text{-Sb}_{0.9}\text{I}_{0.1}$  (I),  $\text{Sb}_{0.6}\text{Se}_{0.4}\text{-Sb}_{0.8}\text{I}_{0.2}$  (II),  $\text{Sb}_2\text{Se}_3\text{-Sb}_{0.7}\text{I}_{0.3}$  (III),  $\text{Sb}_{0.37}\text{Se}_{0.47}\text{I}_{0.16}\text{-Sb}_{0.6}\text{I}_{0.4}$  (IV), and  $\text{Sb}_{0.33}\text{Se}_{0.33}\text{I}_{0.34}\text{-Sb}_{0.5}\text{I}_{0.5}$  (V) in the ternary system Sb-Se-I. The alloys synthesized were studied by methods of differential-thermal analysis, microstructural analysis, and measurement of microhardness. It is established that the area of layer separation in the system  $\text{Sb-Sb}_2\text{Se}_3\text{-SbI}_3$  passes through all fields of crystallization of Sb from the Sb-Se side to the Sb-I side. References 4: all Russian.  
[48-6508]

PHASE DIMENSIONAL EFFECT IN RAPIDLY CONDENSED HIGHLY DISPERSED FILMS  
AND GLASSES

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 21, No 9, Sep 85  
(manuscript received 16 Feb 83) pp 1486-1489

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[Abstract] One manifestation of the phase dimensional effect is a significant drop in melting point of dispersed particles as mean radius decreases. The phase dimensional effect also changes the free energy of formation of a critical seed and the rate of seed formation upon crystallization of an amorphous phase in the highly dispersed state. This effect appears in superthin films of complex semiconductors precipitated by pulsed laser atomization, decreasing the temperature at which layers form and increasing the hardening temperature of the vitreous state of films. The experimental data indicate that increasing the specific surface energy of highly dispersed particles decreases the critical radius of both amorphization seeds and crystallization seeds. References 8: 6 Russian, 2 Western.  
[48-6508]

UDC 669.083.4

DETERMINATION OF ACTIVITY OF MANGANESE IN LIQUID NICKEL BY EVAPORATION  
FROM OPEN SURFACE

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA  
in Russian No 9, Sep 85 (manuscript received 3 Dec 84) pp 20-24

ALEYEV, R.A., BAKANOV, V.K., BALKOVOY, Yu.V., GRIGORYAN, V.A., GOLUB, M.A.  
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[Abstract] The method of evaporation from an open surface is widely used to determine the thermodynamic characteristics of metal melt components. The method is comparatively simple and highly sensitive. It must be conducted under conditions of free evaporation. An equation is presented for determination of the effective evaporation rate constant, which in this case is identical to the Langmuir constant. The method can be used to perform processes under internal diffusion conditions, though this requires determination of the contribution of the kinetic element to the total evaporation rate. An equation is presented for the purpose. The method is used to study kinetic and thermodynamic characteristics of the behavior of manganese in its alloys with nickel. References 12: 4 Russian, 8 Western.  
[50-6508]

## THERMODYNAMIC CHARACTERISTICS OF AMORPHOUS COBALT ALLOYS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA  
in Russian No 9, Sep 85 (manuscript received 28 Sep 84) pp 24-25

ZAKHARCHENKO, K.V., BELASHCHENKO, D.K., KUTSENOK, I.B. and  
GEYDERIKH, V.A., Moscow Steel and Alloys Institute; Moscow State University

[Abstract] A study is performed to determine the emf of a galvanic element consisting of Co<sup>amorphous alloy</sup>|CoCl<sub>2</sub>aqueous solution|Co<sup>crystals</sup> for which the emf is independent of the concentration of cobalt ions in the aqueous solution, being determined only by the thermodynamic activity of the metal in the amorphous alloy. An amorphous alloy of cobalt containing iron, silicon, and boron was studied. The results of emf measurements were processed by the least squares method. It is shown that the method of instantaneous recording of emf is suitable for studies of the thermodynamic characteristics of amorphous alloys. Cobalt-based amorphous alloys characteristically have high values of cobalt chemical potential, decreasing significantly after preliminary annealing at below the temperature at which crystallization begins. References 3: 1 Russian, 2 Western.  
[50-6508]

UDC 669.24'71:539.2:530.145:536.42

## ELECTRON STRUCTURE AND PHASE TRANSFORMATIONS IN Ni-Al ALLOYS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 3,  
Sep 85 (manuscript received 27 Feb 84, in final version 30 May 84)  
pp 421-427

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[Abstract] Mechanisms of phase transformations on the microscopic scale in the Ni-Al system are examined theoretically, for the first time, on the basis of the electron structure. With the aid of data on the electron energy spectrum and the electron states density obtained by measurements and calculations, possible distortions in the crystal lattice and possible instability of the original ordered  $\beta'$ -phase in a nonstoichiometric intermetallic compound are analyzed by the method of Green functions and the Hamiltonian interaction. Interaction of electrons and deviations from a "Lifshits vector-star" in the crystalline field, as well as electron-phonon and phonon-phonon interactions, are taken into account. A characteristic feature of the ordered  $\beta'$ -phase is found to be its Fermi surface with a flat segment intersecting the  $\Delta$ -direction. The equations for the corresponding normal Green function and anomalous Green function, solved simultaneously with



the equation of congruence, yield a whiskered rhombohedral structure in an Ni-Al alloy when a change in composition is accompanied by no change in the chemical potential. References 18: 6 Russian, 12 Western.  
[6602415]

UDC 548.4:620.187

#### THEORETICAL STUDY OF LOW-TEMPERATURE METAL IRRADIATION KINETICS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 3,  
Sep 85 (manuscript received 2 Aug 84) pp 428-434

GOLUBOV, S.I.

[Abstract] Low-temperature irradiation of metals, which produces vacancies and intrinsic interstitial atoms absorbable by various defects in the crystal lattice, is analyzed theoretically on the basis of the corresponding equations of concentration kinetics and balance. Generation of Frenkel pairs, as well as diffusion of intrinsic interstitial atoms and their recombination with vacancies, are taken into account. In the approximation of uniformly distributed sinks for point defects, this system of two equations with zero initial conditions yields a relation between vacancy and intrinsic-interstitial-atom concentrations so that the problem reduces to a single integro-differential equation for the intrinsic-interstitial-atom concentration. In the extreme case of very small radiation doses corresponding to momentary irradiation, according to that equation, this concentration first increases fast to saturation and then decreases slowly. The effectiveness of vacancy pores, vacancy loops, and interstitial loops as sinks is calculated on the assumption that all sinks are in each case of the particular one kind. These calculations are made first for large radiation doses corresponding to a long irradiation time and revealing the kinetics of total defectiveness buildup, then for small radiation doses corresponding to a short irradiation time and to a negligible mobility of vacancies so that the effectiveness of the various different kinds of sinks can be evaluated. The method of analysis is applicable to other kinds of lattice defects, such as gas bubbles or particles of precipitated phases, and their effectiveness as sinks for radiative point defects. References 3: all Russian.  
[66-2415]

## EFFECT OF CORRELATION IN BINARY ALLOY ON TEMPERATURE OF ITS PHASE TRANSITION OF ORDER-DISORDER KIND

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 3,  
Sep 85 (manuscript received 15 Sep 84) pp-444-448

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Nonferrous Metal Alloys and Treatment

[Abstract] A nonferrous binary alloy is treated as a lattice gas, in the approximations of rigid lattices and pairwise interaction. According to this model and the "mean field" theory, its order-disorder phase transition temperature  $T_c$  is a function of the lattice gas concentration  $c$  and of the "mixing" potential  $V$ , that potential depending only on the internodal distance and its Fourier transform depending correspondingly only on the wave vector  $k_0$  of the superstructure reflex. This relation is now refined by including the effect of a correlation in the arrangement of atoms and by thus replacing the one-frequency probability of atom siting with a two-frequency one. Calculations are made for the simple case of transition from a disordered phase to a layered low-temperature superstructure. The "mean field" relation  $T_c = -c(1 - c)V(k_0)$  is accordingly modified into the relation  $T_c = \sum_i \alpha_i(c)V_i$  ( $i$  - number of coordination sphere). Calculation of the coefficients  $\alpha_i$  for the intermetallic compounds CuAu and Cu<sub>3</sub>Au by the Monte Carlo method, these coefficients being constants at a fixed lattice gas concentration  $c$ , yields  $T_c/V_1$  as a linear function of  $\alpha = -V_2/V_1$ . This relation indicates that calculations based on the "mean field" approximation become quite accurate beginning from the third coordination sphere ( $i = 3$ ). References 10: 4 Russian, 6 Western (1 in Russian translation). [66-2415]

UDC 669.24.621.039.531

## OPTICAL ABSORPTION CHARACTERISTICS OF SURFACE OF FERROMAGNETIC NICKEL BOMBARDED BY LOW-ENERGY ARGON IONS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 3,  
Sep 85 (manuscript received 7 May 84) pp 480-487

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[Abstract] An experimental study of the optical absorption characteristics of the surface of ferromagnetic nickel was made, for subsequent application of the results to optical spectroscopy of the bulk metal and determination of its

electron structure. The main purpose was to establish the effect of surface treatment by bombardment with  $<100$  eV  $\text{Ar}^+$  ions and to relate the resulting changes in optical properties to removal of the transitional surface layer. A specimen of 99.99% pure electrolytic nickel with a mirror surface was produced by mechanical grinding and polishing on flannel with a sequence of ASM diamond pastes, then heat treatment for recrystallization and restoration of the broken-down surface layer by annealing at 685 K under a vacuum of  $6 \cdot 10^{-4}$  Pa for 6 h. The specimen as a cathode from ion bombardment was placed inside a vacuum chamber, the latter connected to a goniometer for examination of the surface structure by the method of spectral ellipsometry. The specimen was bombarded and its surface structure was examined both before and after annealing. The refractive index  $n$  and the absorption coefficient  $k$  were measured over the 256-620 nm range of wavelengths, covering both visible and near-ultraviolet regions, then the optical conductivity  $\sigma = nkf$  ( $f$  - frequency of light wave) at each wavelength was calculated. The resulting conductivity spectrum with the ellipsometric data reveals the existence of a fine structure, as well as various structures in both visible and near-ultraviolet regions. Peaks and inflections in that spectrum, contributed by various interband transitions and depending on the surface condition, its degree of purity or contamination, are identifiable here and thus also is the band structure of ferromagnetic nickel with corresponding energy gaps on the basis of its electron energy spectrum. References 27: 7 Russian, 20 Western (1 in Russian translation). [66-2415]

UDC 669.293'783:535.33/.34

#### OPTICAL PROPERTIES AND ELECTRONIC CHARACTERISTICS OF Nb-Ge COMPOUNDS WITH A15 LATTICE

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 3, Sep 85 (manuscript received 11 Dec 84) pp 488-493

KUZMICHEV, N.D., LEVCHENKO, I.S. and MOTULEVICH, G.P., Institute of Physics imeni P.N. Lebedev, USSR Academy of Sciences

[Abstract] An experimental study of Nb-Ge intermetallic compounds was made which included measurement of their optical properties for calculation of their complex dielectric permittivity over the 0.177-3.1 eV range of the electron energy spectrum at two temperatures: 295 K and 670 K. Two specimens for this experiment were produced by simultaneous vaporization of the two components under vacuum and subsequent condensation of their vapor mixture on polished sapphire substrates. Niobium was vaporized with an electron beam, germanium was vaporized from a tungsten vessel by plain heating. The properties of both specimens were determined on the basis of optical measurements, including ellipsometry; their structure was examined in a DRON-2 x-ray diffractometer. The first specimen was found to be a homogeneous one consisting almost entirely of the A15 phase, with 17 of all 18 diffraction lines corresponding to an A15 lattice and the (110) line among

them indicating an ordered Al<sub>5</sub> phase. The second specimen was found to consist of approximately 60% Al<sub>5</sub> phase (18 diffraction lines) accompanied by the 6-phase (7 diffraction lines) and the NbO phase (2 diffraction lines), with the (110), (220), (330) lines among the 18 indicating an ordered Al<sub>5</sub> phase. A quantitative analysis of the two films in an MAR-2 instrument revealed a nonstoichiometric composition with excess niobium: Nb<sub>0.80</sub>Ge<sub>0.20</sub> and Nb<sub>0.81</sub>Ge<sub>0.19</sub>. Their optical constants were measured with an instrument including a vacuum chamber under a pressure of  $7.5 \cdot 10^{-9}$  -  $7.5 \cdot 10^{-8}$  Pa for ellipsometry. Both real and imaginary parts of the dielectric permittivity, each a function of the frequency of incident electromagnetic radiation, were then calculated on the basis of their relations to the refractive index and the absorption coefficient - after the experimental data had been smoothed on a computer with third-degree polynomials using seven nonequidistant points and the method of least squares. Also calculated were the energy gaps, the widths of energy bands, and the plasma frequencies of the homogeneous Al<sub>5</sub>-phase Nb<sub>0.80</sub>Ge<sub>0.20</sub> compound at both temperatures. The results reveal a strong temperature dependence of all these three parameters characterizing Bragg rather than Drude interband transition bands, and the existence of several, at least six, such bands along with the conduction band within the infrared region, as well as in the  $\hbar\omega > 3$  eV region of the energy spectrum. References 12: 9 Russian, 3 Western.

[66-2415]

UDC 669.15'24'25:539.216.2:539.221

#### LOCALIZED DEFECTS IN AND COERCIVE FORCE OF THIN MAGNETIC FILMS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 60, No 3, Sep 85 (manuscript received 22 Jan 85) pp 623-624

OSUKHOVSKIY, V.E., VOROBYEV, Yu.D., SLABZHENNIKOVA, I.M. and NAUMENKO, L.F., Far Eastern State University

[Abstract] Interaction of a domain wall and localized defects in thin films of Ni<sub>80</sub>Fe<sub>20</sub>, Ni<sub>63</sub>Co<sub>25</sub>Fe<sub>12</sub>, Co<sub>50</sub>Fe<sub>50</sub> is analyzed on the basis of microphotographs taken under an electron microscope in a magnetic field during buildup of the latter. For a subsequent determination of the two components of the coercive force  $H_c = H_0 + H_D$  ( $H_0$  due to pinned domain wall,  $H_D$  due to localized defects) and their dependence on that interaction, controllable nonmagnetic inclusions in the form of microscopic MgO crystals of the 1  $\mu$ m size fraction were implanted in the magnetic films as artificial defects. The interaction of these defects and a domain wall were found to appreciably increase the  $H_D$  component of the coercive force only as the concentration of artificial defects exceeded  $n = 5 \cdot 10^4$  cm<sup>-2</sup>, with the mean distance between defects  $l < 40$   $\mu$ m remaining much smaller than the width  $\delta$  of a domain wall. The difference between the total component  $H_D$  of coercive force and the increment  $\Delta H_D$  upon implantation of artificial inclusions is then the

coercive force  $H_{D0}$  due to original defects produced as a result of imperfect film technology, and this increment  $\Delta H_D$  was found to be proportional to  $n^{\frac{1}{2}}$  within the  $n = 5 \cdot 10^4 - 3 \cdot 10^6 \text{ cm}^{-2}$  range for  $\text{Ni}_{63}\text{Co}_{25}\text{Fe}_{12}$ . In the  $n > 3 \cdot 10^6 \text{ cm}^{-2}$  range, moreover,  $H_0$  was found to increase more appreciably than proportionally to  $n^{\frac{1}{2}}$ . References 5: 3 Russian, 2 Western. [66-2415]

UDC 620.179.16

# REFLECTION OF LONGITUDINAL AND TRANSVERSE ELASTIC WAVES BY CRACK OF FINITE DIMENSIONS

Sverdlovsk DEFEKTOSKOPIYA in Russian No 9, Sep 85 (manuscript received 19 Dec 84) pp 12-18

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[Abstract] Reflection of two orthogonally polarized plane elastic waves by a crack of semi-infinite length but finite width is considered for application to ultrasonic inspection, the two waves propagating one longitudinally and one transversely. Analysis and calculations in a system of elliptic cylindrical coordinates are based on the corresponding homogeneous Helmholtz scalar equation and the displacement vector, with the initial conditions stipulated for a harmonic incident wave and the solution obtained separately for symmetric and antisymmetric reflected waves. The defect form factor is calculated for each case in the approximation of extremely short waves. Since the variables in the boundary conditions are not completely separable, the coefficients in the elliptic series expansions of the potentials of reflected waves are necessarily calculated from the corresponding infinite system of equations by the reduction method. The problem is solved for the special case of normal incidence. References 7: 5 Russian, 2 Western (1 in Russian translation). [67-2415]

UDC 620.179.14

# TUNE-OUT OF AIR GAP FOR INSPECTION OF FLAT OBJECTS BY PHASE METHOD

Sverdlovsk DEFEKTOSKOPIYA in Russian No 9, Sep 85 (manuscript received 14 Jun 84, in final version 24 Dec 84) pp 27-31

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[Abstract] The design of a lay-on eddy-current transducer for inspection of flat objects is shown which will tune out the air gap as variable

influencing the measurement. Analysis of the problem is based on using the phase rather than the amplitude of the transducer output signal as defect indicator and ensuring the minimum possible change in signal phase upon changes in the gap width but the maximum possible change in signal phase upon changes in the generalized inspection parameter. Calculations are made for a transducer with the current (magnetizing) coil and the voltage (measuring) coil spread apart sufficiently to ensure a straight tap line on the normalized voltage-phasor hodograph, both width and thickness of each coil being much smaller than its diameter. Hodographs are calculated on this basis for two thin and narrow coils of equal diameters, first lying next to one another in one plane (their axes parallel) and then lying in planes perpendicular to one another (their axes orthogonal). These theoretical hodographs agree closely with experimentally determined ones. The operating point can therefore be correctly selected in the complex plane for complete tune-out of the air gap. References 2: both Russian.  
[67-2415]

UDC 620.179.14

#### CHARACTERISTICS OF EDDY-CURRENT FLAW DETECTION IN BENT TAPS FROM REACTOR PIPING IN AES

Sverdlovsk DEFEKTOSKOPIYA in Russian No 9, Sep 85 (manuscript received 6 Sep 84, in final version 17 Jan 85) pp 31-35

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[Abstract] Ensuring reliable performance of reactor piping in an AES requires monitoring this piping for discontinuities in the metal, which are particularly likely to develop in bends. An inspection procedure involving use of a special lay-on eddy-current transducer with a conical ferrite core and amplitude-phase processing of its unbalance signal has been developed for this purpose and was experimentally applied to bent taps made of OKh18N10T steel, nominally 28 mm in diameter with 2 mm wall thickness. The transducer core was made of 400NN ferrite, 14 mm long and 1.8 mm in diameter at the base, wound with PEL-0.08 mm enameled lacquer-proof copper wire producing an mmf of 20 ampere-turns. Taps were inspected when new and after 37,000 h of operation at 260°C under an internal pressure of 6.0 MPa, also after 53 start-stop cycles. For control tests, artificial cracks 15 mm long and 0.08 mm wide were produced in some taps up to 2.0 mm deep with a 4G-721 electric erosion machine. On the basis of the experimental data, after compensation in air or on the neutral axis of a bend, increments of the unbalance signal amplitude have been correlated with changes in three characteristics of the tap metal: 1) hardness on the Rockwell C scale; 2)  $\alpha$ -phase content in the surface layer, according to measurements with an FA-1 ferrite meter accurate within 10%; 3) circumferential and longitudinal stresses at the outer bend surface under internal pressure, with distortion of the tap pipe cross section taken into account. These correlations,

plotted on polar nomograms, indicate not only the necessity of including the defect location as a variable on which the increment of the unbalance signal amplitude depends but also the necessity of scanning a bend section along two paths, with the transducer moving from the neutral axis first through the elongated zone and then through the contracted zone back to the neutral axis. A set of hodographs has been plotted accordingly to represent the relative increment of the transducer output voltage as a function of the defect depth, of the space coordinate locating the transducer around the bend section, of the strain under uniaxial tension, of the relative tap wall thickness, and as a function of the relative gap width. References 5: all Russian.

[67-2415]

UDC 620.179.18

#### FLAW DETECTION IN SPUTTERED COATINGS BY HOLOGRAPHIC INTERFEROMETRY WITH THERMAL LOADING

Sverdlovsk DEFEKTOSKOPIYA in Russian No 9, Sep 85 (manuscript received 20 Jul 83, in final version 16 Apr 84) pp 90-92

SUMINOV, V.M., SHANIN, V.I. and SEMENOVA, A.N., Moscow Aviation Technological Institute imeni K.E. Tsiolkovskiy

[Abstract] Holographic interferometry with vibrational loading is successfully used for flaw detection in relatively thick sputtered coatings, but thin coatings on thick substrates require a different method of loading. Thermal loading was tried experimentally on beryllium bushings (length 13 mm, inside diameter 10 mm, flange diameter 20 mm, flange thickness 3.5 mm) with  $Al_2O_3$  ceramic coatings on the surface of the much thicker flange. Such a bushing was slipped into the sleeve of a fixture uniformly pressing on the flange, the fixture being rigidly coupled to a holographic table. Such a bushing was thermally loaded by means of a 50 W heating rod inserted into it. Interference patterns were produced with an LG-52 laser according to the conventional 2-beam scheme. Holograms were recorded on Mikrat-LOI-2 photographic plate by the double-exposure method. A characteristic feature of the interferograms was additive superposition of the fine interference pattern on the principal image. Comparison of holograms of defective and nondefective coatings, with matching of the sleeve material and the pressure force on the flange, allowed not only a qualitative interpretation of interferograms but also their quantitative decoding. On the basis of 200 samples, inspection by this method was found to remain reliable with reproducible results even with sleeve and heater manufacturing imprecision, as long as the resulting sleeve and heater anisotropy did not exceed the imprecision of flange surface treatment. Thermal loading was also found to remain suitable in the case of defects producing differences in thermal conductivity and consequently displacements of a coating on the substrate, displacements within the sensitivity range of holographic interferometry. References 3: 2 Russian, 1 East German.

[67-2415]



STRUCTURE AND PROPERTIES OF 65G STEEL AFTER LOW-TEMPERATURE  
THERMOMECHANICAL TREATMENT AND THEIR DEPENDENCE ON TEMPERING TEMPERATURE

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 21, No 5,  
Sep-Oct 85 (manuscript received 4 May 84) pp 33-36

KOZYRSKIY, O.I. OPALCHUK, A.S., KHRUNIK, R.A., KATSOV, K.B.,  
KOKOTAYLO, I.V. and SEMENOVSKIY, A.Ye., Ukrainian Agricultural Academy,  
Kiev; Physical Mechanical Institute imeni G.V. Karpenko, UkSSR Academy of  
Sciences, Lvov

[Abstract] Low-temperature thermomechanical treatment of 65G tractor steel was studied for the purpose of determining the dependence of its structural transformations as well as its wear resistance and fatigue strength in contact on the tempering temperature. Specimens of 2 mm thick sheet were preaustenitized at 900°C and rapidly subcooled from a temperature slightly above the martensite transformation point. At that subcooling temperature they were rolled to 10-20-30-40-50% deformation, whereupon they were water-cooled before being tempered at 100-200-300-400°C for 1 h at each temperature. A subsequent x-radiographic examination in a DRON-0.5 diffractometer with a  $\text{FeK}_\alpha$ -radiation source has revealed that, as the tempering temperature is raised, the crystalline structure of this steel changes with a narrowing of both the  $B_{111}$  austenite line and the  $B_{220}$  martensite line. Tempering at a higher temperature also decreases microstresses and the amount of residual austenite, enlarges coherently scattering clusters, and destroys the tetragonality of martensite. Some specimens were ground by means of a corrosive-abrasive agent for determination of their wear resistance, others were rolled against rings made of ShKh15 ball-bearing steel (quenched and tempered to HRC 60-62 hardness) under an alternating contact stress with 2 GPa "Hertz" amplitude and with 15% slip. The results of these tests indicate that thermomechanical treatment to a 30% deformation with subsequent tempering at 200°C is optimum for this particular steel. References 5: 3 Russian, 2 Western.  
[78-2415]

USE OF HELIUM AS MEDIUM FOR LOW-TEMPERATURE FATIGUE TESTING OF METALS

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 21, No 5,  
Sep-Oct 85 (manuscript received 25 Mar 85) pp 119-120

YAKOVENKO, L.F., Low Temperatures Physical Technical Institute, UkSSR  
Academy of Sciences, Kharkov

[Abstract] Considering that the life of copper objects under cyclic load does not become significantly longer as the ambient air pressure is



decreased below  $1.33 \cdot 10^{-6}$  Pa and that above this threshold the extension of life under decreasing pressure is determined by the oxygen content in the residual ambient air, a high vacuum ( $1.33 \cdot 10^{-2}$  Pa air) is desirable for comparative fatigue testing at various temperatures including cryogenic ones. Since vacuum-tight equipment for such tests is difficult to construct, use of an inert gas becomes preferable - as long as the oxygen impurity remains sufficiently small. Helium is most suitable from this standpoint, inasmuch as oxygen solidifies at approximately 54 K. The feasibility of using helium for such tests has been confirmed experimentally on bars of polycrystalline M2 copper. Bars with a trapezoidal cross-section, vacuum annealed at 993 K for 2 h so as to ensure uniformity of life data with  $\pm 15\%$ , were mounted in cantilever manner and tested in cyclic flexure under a stiff load. They were tested not only at 4.2 K in liquid helium but, for comparison, also at room temperature in air and in an atmosphere of gaseous helium, the latter produced either by admission of liquid helium into the cryostat after its evacuation to 1.33 Pa air or by continuous pumping of helium vapor through the test chamber. With the amplitudes of total strain and plastic strain  $16 \cdot 10^{-4}$  and  $3 \cdot 10^{-4}$ , respectively, at 293 K, the life of those copper bars was  $2.4 \cdot 10^5$  cycles in air,  $9.3 \cdot 10^5$  cycles in helium vapor, and  $18.5 \cdot 10^5$  cycles in gaseous helium. With the amplitudes of total strain and plastic strain  $27 \cdot 10^{-4}$  and  $3.0 \cdot 10^{-4}$ , respectively, at 4.2 K, the life of those copper bars was  $13.0 \cdot 10^5$  cycles in liquid helium. A comparative analysis of these data indicates that the life of copper bars is 30% shorter at 4.2 K than at 293 K, being as much shorter under vacuum than under atmospheric pressure, and that a change of the ambient medium from helium to air shortens their life much more appreciably. References 3: 1 Russian, 2 Western.  
[78-2415]

UDC 669.293.786:538.214:537.312.62

#### STRUCTURE OF GAS PHASE NIOBIUM NITRIDE COATINGS

Moscow TSVETNYYE METALLY in Russian No 10, Oct 85 pp 87-89

MITROKHIN, V.A., RYCHAGOV, A.V., MAVRINA, T.N., TARAN, L.A. and YURKOVA, R.S.

[Abstract] Chemical precipitation of coatings on molybdenum wire 1.5 mm in diameter was performed from a vapor-gas mixture containing niobium pentafluoride, nitrogen, and hydrogen in the 800-1600°C temperature range. The specimens obtained were analyzed for nitrogen and oxygen content; the structure of the coatings was studied with an optical microscope and a scanning electron microscope. Metallographic analysis included etching of specimens with a solution of nitric acid plus hydrofluoric acid and glycerine. Results showed that in the tetragonal niobium nitride obtained by fluoride precipitation from the gas phase the ratio of lattice parameters  $c/a$  varies linearly as a function of nitrogen concentration. In coatings of

hexagonal niobium nitride the lattice parameter varied from 49.48 to 49.96 nm, parameter a remaining constant at 30.54 nm. Precipitation of hexagonal  $\beta$ -Nb<sub>2</sub>N in all cases formed 2-layer coatings; a thin layer of small crystals next to the substrate, from which crystals of the main coating with columnar structure and growth direction perpendicular to the substrate later grew. Measurement of the transition temperature to the superconducting state for coatings of various compositions showed that in the area of homogeneity of  $\beta$ -Nb<sub>2</sub>N, changes in critical temperature are practically not observed. It was  $7.2 \pm 0.2$  K for the specimens studied. For  $\gamma$ -NbN, the variation of critical temperature as a function of phase composition was not determined, though for the lower boundary of the area of homogeneity it was about 10.0 K. Increasing the c/a ratio to 9.85 nm increased the critical temperature to  $18.2 \pm 0.4$  K. References 8: 6 Russian, 2 Western.  
[59-6508]

SCIENTIFIC AND TECHNICAL CONFERENCE ON METROLOGIC SUPPORT OF ANALYTIC TESTING IN NONFERROUS METALLURGY

Moscow TSVETNYYE METALLY in Russian No 10, Oct 85 pp 118-119

NEYMAN, Ye.Ya.

[Abstract] The conference on metrologic support mentioned in the title is described, though its precise location and dates are not mentioned. Subjects discussed included major trends in the activity of metrology services in the industry, the system of metrologic support of nonferrous metallurgy, the procedures for determination of norms for accuracy in the establishment of content norms for components and impurities in materials, provision of the necessary variety and quantity of branch standards of all categories, the requirements of the State standards organizations for standard technical documentation, and problems of analytic testing. Recommendations were adopted, which are intended to increase the level of analytic testing in the industry. Specifics are not given.  
[59-6508]

/13046

## COATINGS

### SILVER PILFERAGE NOTED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 18 Oct 85 p 2

[Article: "'A Sack of Silver'"]

[Text] In correspondence published in SOTSIALISTICHESKAYA INDUSTRIYA under this headline on September 3, the topic was the poorly organized control over the availability and consumption of silver in production of silver-plated table utensils at the Olenegorsk Machine Plant, resulting in its pilferage. In its reply to the newspaper's speaking out, the head of the All-union Production Association for industrial machine building for nonferrous metallurgy of the USSR Mintsvetmet [Ministry of Nonferrous Metallurgy] L. Parfenov informed us that the shortcomings which were noted actually took place.

The plant director and a shop foreman were removed from the positions they occupied for the unsatisfactory work of the table utensils shop. A number of workers at the table utensils shop, whose fault it was that above-norm silver losses were permitted, were called to material responsibility.

But, as comrade Parfenov informs us, the new leaders in the enterprise also permitted individual shortcomings in their work. Plant director M. Polyakov was reprimanded for unsatisfactory organization of the pass control operation, and assistant director V. Golubev was reprimanded and fined a monetary fine of one month's salary. Measures are presently being taken by the plant to eliminate those violations noted in the newspaper article.

Directives were issued to the plant to improve the pass control system and to increase the responsibility of management and the engineering and technical workers for the status of the security of the precious metals used in production.

The improvement of operations to monitor the observance of technological discipline in the production of table utensils was also expressed in the fact that the plant now has no complaints from trade organizations because of the items being poorly plated with silver.

9194/13046  
CSO: 1842/55

UDC 546.56:539.216.2

#### INFLUENCE OF SILICON NITRIDE ON PRECIPITATION OF COPPER CHEMICAL COATINGS

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 21, No 9, Sep 85  
(manuscript received 15 Oct 84) pp 1578-1579

GUSEVA, I.V., MASHCHENKO, T.S. and BORISENKO, A.I., Silicate Chemistry  
Institute imeni I.V. Grebenshchikov, USSR Academy of Sciences

[Abstract] A study is made of the process of formation of  $\text{Cu}+\text{Si}_3\text{N}_4$  chemical coatings. When silicon nitride was introduced to a chemical copper-plating solution, it was found to have a significant influence on the mixed potential and rate of precipitation of coatings. As  $\text{Si}_3\text{N}_4$  concentration increased in the suspension, the rate of precipitation decreased, while the mixed potential shifted in the direction of more positive values in comparison to the copper reduction potential, indicating that electrochemical factors influenced chemical precipitation. The slowing in the process of formation of coatings of  $\text{Cu}+\text{Si}_3\text{N}_4$  in comparison to the rate of precipitation of copper coatings can be explained by the influence of the  $\text{Si}_3\text{N}_4$  both on the electrochemical (anodic component) and on the chemical parts of the process of copper plating, apparently due to shielding of certain active catalytic centers on the surface being coated. References 3: all Russian.  
[48-6508]

IDC 546.3-19

#### HEAT-RESISTANT COATINGS ON NICKEL ALLOYS

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 21, No 9, Sep 85  
(manuscript received 15 Oct 84) pp 1584-1587

ANTONOVA, Ye.A., SINAY, L.M., PUSTOTINA, S.R. and ROMANOV, A.Yu., Silicate Chemistry Institute imeni I.V. Grebenshchikov, USSR Academy of Sciences

[Abstract] A search was undertaken for heat-resistant coatings containing Ni, Cr, W, Si, and Al with formation temperature below  $1300^\circ\text{C}$ . Carbon was introduced to the composition of the coatings to decrease formation temperature. The studies established that the formation temperature of

coatings depends on the composition of the alloy. Alloying elements, particularly Mo, W, and Ti, diffuse from the alloy into the coating and decrease the temperature of its formation. It is shown that in high-temperature isothermal holding (1100°C for 100 hours) the effectiveness of the protection action of coatings decreases as a result of active diffusion processes and changes in alloy structure. References 1: Russian.  
[48-6508]

UDC 620.181;620.198;621.357.7

#### HEAT RESISTANCE OF COMPOSITE NICKEL-BASED ELECTROCHEMICAL COATINGS

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 21, No 9, Sep 85  
(manuscript received 15 Oct 84) pp 1587-1589

POKHMURSKIY, V.I., DALISOV, V.B., GUSLIYENKO, Yu.A. and MARDAREVICH, R.S.,  
Physical Mechanical Institute imeni G.V. Karpenko, Ukrainian Academy of  
Sciences

[Abstract] Composite electrochemical coatings 80-100  $\mu\text{m}$  thick were precipitated from a chloride nickeliding electrolyte onto specimens of type 45 steel and annealed in a vacuum at 850 and 1050°C for 1 and 2 hours, respectively. During annealing, diffusion interaction occurs in the nickel coating, which contains dispersed amorphous boron particles, resulting in the forming of nickel borides  $\text{Ni}_3\text{B}$  distributed through the matrix as a solid solution of boron in nickel. Increasing annealing time and temperature results in enlargement of the boride sections and reduction in the thickness of the matrix intermediate layers. The films were oxidized in air at 500 and 900°C for 6-100 hours and evaluated on the basis of the change in mass. Ni-B coatings applied to carbon steel were found to be capable of long-term use at temperatures of up to 750°C. Above this point the nickel borides begin to decompose and oxidize rapidly. The composite coatings can be used for long periods of time if they do not contain unreacted boron. References 5: all Russian.  
[48-6508]

UDC 54.123.3:[546.784.261+546.73+546.27]

#### FORMATION OF COMPOSITE WC-Co-B COATINGS

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 21, No 9, Sep 85  
(manuscript received 15 Oct 84) pp 1591-1593

KREYCHMAN, B.M., BUROV, B.G. and PERFILOV, M.Ye., Novosibirsk Electrical  
Engineering Institute

[Abstract] The purpose of this work was the development and investigation of a multistage technology for composite coatings based on tungsten carbide-cobalt-boron on the surface of products from structural materials.

Electrophoretic precipitation onto specimens of type 3 and 45 steel and VT-20 titanium alloy from suspensions in ethyleneglycol was undertaken. The maximum precipitation rate was 25  $\mu\text{m/s}$ . Greatest uniformity of alternation of components, density, and covering capacity were obtained at electric field strengths of 250-400 V/cm. After drying, the electrophoretic coatings were sintered in a vacuum of  $1 \cdot 10^{-1}$  Pa at 1180-1200°C, i.e., 30-50°C above the melting point of the eutectic in the Fe-B system. The thickness of the coating precipitated was 50-70  $\mu\text{m}$ . The hardening phase of the coatings on steel consisted of crystals of the initial powder WC. Pulsed laser heating of the coatings had an energy selected to melt the cobalt phase without evaporation which resulted in perceptible transfer of tungsten carbide grains into the melt and replacement of diffusion with convection in redistribution of the substances. References 6: all Russian. [48-6508]

UDC [546.261/171+541.45]:539.216.2

#### PROTECTIVE COMPOSITE MATERIAL COATINGS

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 21, No 9, Sep 85  
(manuscript received 15 Oct 84) pp 1596-1599

KARPINOS, D.M., LISTOVNICHAYA, S.P. and KRISON, M.Ye., Institute of Metal Science Problems, USSR Academy of Sciences

[Abstract] The problem of stabilizing the interface in composite materials can be solved by creation of diffusion barriers on the reinforcing component by application of a stable coating intended to slow mass transfer at the interface and assure good bonding between matrix and fibers. Carbide coatings have been found to be promising for use at high temperatures. Recent data indicate that the most promising materials for diffusion barriers may be oxide films. Studies of compatibility in composites based on tungsten and molybdenum fibers with coatings of aluminum oxide in nichrome matrices have shown that a protective layer 1 to 3  $\mu\text{m}$  thick assures stability of the interface between reinforcing phase and matrix at temperatures of 1100-1200°C for 80-100 hrs. References 6: 5 Russian, 1 Western. [48-6508]

## PRECIPITATION OF CHROMIUM CARBIDES ON STEEL IN CARBON TETRACHLORIDE ATMOSPHERE

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 9, Sep 85 (manuscript received 11 Dec 84) p 173

LOSKUTOV, V.F., TEREITYEV, A.F. and KHIZHNYAK, V.G., Kiev Polytechnical Institute

[Abstract] A study was made of the influence of carbon tetrachloride temperature at entry to reaction space on the phase composition and thickness of chromium carbide based layers precipitated on the surface of steel types 20, 45, U8A, and U10A. Coatings were applied at 1323 K and held 2 hours in a closed reactor at reduced pressure, using chromium powder, a carbon-containing additive, and carbon tetrachloride as the reagents. The studies showed that when chromium carbides are precipitated onto the surfaces of the steels studied, introduction of carbon tetrachloride to the reaction space should be performed at 1273-1323 K. References 1: Russian. [50-6508]

## RESISTANCE OF 15Kh2MFA STEEL WITH ANTICORROSIVE CLADDING TO CYCLIC CRACKING

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 21, No 5, Sep-Oct 85 (manuscript received 17 Mar 85) pp 40-48

ZVEZDIN, Yu.I., NIKIFORCHIN, G.N., TIMOFEYEV, B.T., ZIMA, Yu.V. and ANDRUSIV, B.N., Physical Mechanical Institute imeni G.V. Karpenko, Lvov

[Abstract] A study of 15Kh2MFA heat-resistant steel with austenitic anti-corrosive cladding was made for determination of the resistance to cracking within the transition zone under a cyclic load, this combination of materials being under consideration for vessels of water-moderated water-cooled power reactors. Specimens of this steel were doubly clad by automatic welding, the 1.3-6 mm thick first layer with Sv-07Kh25N13 electrodes and the second layer with Sv-08Kh19N10G2B electrodes to a total cladding thickness of 9-10 mm. Rectangular bars 160 mm long and 12x18 mm<sup>2</sup> in cross-section with a crack at the edge were mounted in cantilever manner and tested in flexure at room temperature, under a load alternating at a frequency of 10 Hz with a 0.05 or 0.5 cycle asymmetry factor. The crack, originating at a stress concentrator, was propagated by stepwise load dropping so that its tip would be located at least 2.5 mm away from steel-cladding boundary under the threshold stress intensity. Microstructural examination had revealed a heterogeneous transition zone extending into the base metal and into the cladding metal on both sides of the boundary. Measurements with semiconductor-type tenso-resistors and a high-sensitivity displacement transducer yielded

data necessary for plotting force-strain curves and calculating the threshold stress intensity coefficient as well as the effective fraction of the nominal stress intensity coefficient equal to the difference between the maximum stress intensity coefficient and the stress intensity coefficient corresponding to an open crack. Subsequently calculated curves of the fatigue fracture kinetics and stress intensity profiles, as well as cracking rate profiles, indicate a larger gradient of resistance to crack propagation from base metal to cladding metal than of resistance to crack propagation in the opposite direction. On the basis of all these data, taking into account the crack geometry and the fracture micromechanism as well as the effect of crack closure in terms of the ineffective part of threshold stress intensity, a model is constructed of crack propagation and crack inhibition in such pairs of mechanically dissimilar materials. On the basis of this model, it is also possible to evaluate the effect of annealing, predict the safety margin of reactor vessels and thus the mechanical life of reactors, and recommend preventive measures such as minimization of the load cycle asymmetry. References 15: 12 Russian, 3 Western (1 in Russian translation).

[78-2415]

UDC 620.178.162

#### EFFECT OF CORROSIVE MEDIUM ON WEAR RESISTANCE OF EUTECTIC AND CHROMIUM COATINGS

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 21, No 5, Sep-Oct 85 (manuscript received 3 Apr 85) pp 99-100

KOZUB, V.V., GOLUBETS, V.M., PASHCHENKO, M.I. and NAUMENKO, V.B.,  
Physical Mechanical Institute imeni G.V. Karpenko, UkSSR Academy of Sciences, Lvov

[Abstract] An experimental study of eutectic and chromium coatings on 45 carbon steel was made for determination of their resistance to corrosive-abrasive wear. Tests were performed on "sleeve-plug" friction pairs in three suspensions of quartz sand in 3% NaCl solution with the pH = 12, 7.4, 1, respectively, with the plugs sliding at velocities of 0.4, 0.6, 0.8 m/s under a load varying from 0 to 5 MPa. The plugs had been chromized by diffusion prior to deposition of a eutectic coating and the sleeves had been borated by diffusion, special containers with fusible seals being used for impregnation by diffusion. Chromizing was done at 1100°C for 10 h to produce a layer of 16-18 GPa microhardness and borating at 950°C for 6 h to produce a layer of 14-16 GPa microhardness. Eutectic coatings were deposited from grease, with heating by a high-frequency electric current at 1150-1250°C for 4 s to produce a layer of 9-12 GPa microhardness. After having been ground to size, the specimens were tested in those corrosive-abrasive media. The results reveal diverse effects of the corrosive media on the wear rate relative to that in dry sand, decreasing or increasing by various amounts depending on the rubbing velocity and the load. Cracks and



voids were found to appear in the diffusion layers. A eutectic coating on chromized plugs generally reduced the total wear and thus increased the wear resistance of these pairs. References 5: all Russian.  
[78-2415]

/13046

## COMPOSITE MATERIALS

UDC 620.168:678.067

### STUDY OF INFLUENCE OF LONG-TERM EFFECT OF TEMPERATURE AND MOISTURE ON ELASTIC PROPERTIES AND STRUCTURE OF ORGANIC PLASTIC

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 4, Jul-Aug 85  
(manuscript received 16 Jan 85) pp 620-623

ANISKEVICH, K.K., KURZEMNIYEKS, A.Kh. and YANSON, Yu.O., Institute of Polymer Mechanics, Latvian SSR Academy of Sciences, Riga

[Abstract] An experimental study is presented on the influence of long-term exposure to temperature and moisture on the elasticity modulus of organic plastic, as well as on the structure of reinforcing fibers in a composite. Specimens of fiber-reinforced epoxy composites were wet in water at 60°C, either continually or alternating with drying, also at 60°C. Thermal aging yields a qualitative correlation between changes in modulus of elasticity of the plastic and changes in the degree of order of the reinforcing fibers. Depending on aging time at up to 140°C, it is possible to observe at interval growth in the modulus of elasticity of the composite and an improvement of fiber structure plus an interval of deterioration of these characteristics. Structural studies indicate that there are differences between aging of SVM fiber in a composite and the fibers individually. Long-term exposure to moisture causes a significant decrease in the elasticity modulus of the composite and a disordering of the structure of the reinforcing fibers as a result of weakening of intermolecular interactions due to water absorption. References 8: 7 Russian, 1 Western.  
[53-6508]

UDC 624.074:678.067

### STABILITY AND INCREASE IN DELAMINATION IN CYLINDRICAL SHELL OF COMPOSITE MATERIAL UPON COMPRESSION

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 4, Jul-Aug 85  
(manuscript received 4 Feb 85) pp 653-657

KISLYAKOV, S.A., Moscow Power Engineering Institute

[Abstract] A study is made of a multilayer orthotropic cylindrical shell exposed to 'rigid' loading with compressive deformation. Delamination occurs

near the inner surface of the shell in the form of an ellipse. It is assumed that the major directions of elasticity and the coordinate axes and major axes of the ellipse coincide, while the center of ellipse is at the coordinate origin. If there is no loading, delamination bending at the coordinate origin is assumed equal to zero. It is also assumed that the thickness of the delamination layer is much less than the thickness of the entire shell, and the dimensions of the defective area being small in comparison to the radius of the shell. Equations are derived for delamination upon cyclical loading. Under heavy loading, delamination increases more rapidly and reaches greater dimensions, which corresponds to experimental data. References 10: 7 Russian, 3 Western.  
[53-6508]

UDC 539.37:678.067

STUDY OF STRESS-STRAIN STATE OF THREE-LAYER CONICAL SHELLS WITH ENVELOPES OF HIGH-MODULUS COMPOSITE MATERIALS

Riga MEKhanika Kompozitnykh Materialov in Russian No 4, Jul-Aug 85  
(manuscript received 5 Dec 84) pp 658-664

KOTELNIKOV, V.U., MOROZOV, V.A., MOKRYI, S.V. and YURIN, G.I., Rostov Higher Military Command-Engineering School of Rocket Forces imeni Chief Marshal of Artillery M.I. Nedelin

[Abstract] Specifics of the technological process have a great influence on the process of deformation and the load-bearing capacity of three-layer structures with envelopes of high-modulus composite materials, since the manufacture of multilayer shells is usually performed with simultaneous formation of the composite material. The problem of effective production of a number of large three-layer shells is frequently solved by the use of vacuum molding of products. Two batches of truncated conical shells with carbon-reinforced plastic and glass-reinforced plastic load-bearing layers and inside diameters of 930 and 240 mm at the larger and smaller ends with a half-aperture angle of  $28^\circ$  were produced and tested. Results of the testing are presented as distributions of the deformations of the envelopes along the conical shell generatrix for pressures of 0.0784, 0.157, and 0.235 MPa and the coefficient of weight effectiveness. Equations are derived for a theoretical estimate of the stress-strain state in the shells. A two-dimensional curved orthotropic model with mean values of the moduli of elasticity in the circular and meridional directions was used for the theoretical computations. References 7: all Russian.  
[53-6508]

## SCIENTIFIC FOUNDATIONS OF ENGINEERING CLIMATOLOGY OF POLYMER AND COMPOSITE MATERIALS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 4, Jul-Aug 85  
(manuscript received 17 Sep 84) pp 708-714

URZHUMTSEV, Yu.S. and CHERSKIY, I.N., Institute of Physical and Technical Problems of the North, Yakutsk Branch, Siberian Department, USSR Academy of Sciences, Yakutsk

[Abstract] A study is made of new methodological approaches to the investigation of the aging of polymer and composite materials allowing for the creation of the scientific foundations of an engineering climatology of polymer materials and intended for the solution of applied problems related to the prediction of the efficiency of equipment in cold climates. The influence of the factors of the most characteristic climatic zones on the atmospheric durability of polymer materials is studied, including a hot dry zone, a hot moist zone, and a very cold zone. Analysis of the efficiency of products, the severity of climate, and the results of the aging of polymers reveal a contradiction: the aging of polymers under the conditions of the very cold zone produces less change in structure than does aging in hot and wet areas, leaving the question of the obvious reduction in durability of the materials in cold climates open. It is found that testing of aged specimens at room temperature, observing slight changes in short-term strength and deformation characteristics, leads one to believe that the materials are resistant to atmospheric exposure. However, the process of aging develops actively and the efficiency of materials is greatly reduced at below-freezing temperatures. This means that existing methods of testing materials are not suitable for use on materials intended to be used in the far north. Use of the endochronic theory of viscoelasticity and quasi-static test methods do allow timely studies of changes in the elastic and inelastic characteristics of materials as they age. References 15: all Russian.  
[53-6508]

## ESTIMATING SHEAR STRENGTH BETWEEN LAYERS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 4, Jul-Aug 85  
(manuscript received 16 Aug 83) pp 723-728

MIKHAYLOV, V.V., GUNYAYEV, G.M., IVANOVA, L.A. and KUZNETSOVA, M.A.

[Abstract] The shear strength of the interface between layers of composite materials is frequently determined by bending of thick rectangular rods. This method has a number of shortcomings, and increases in shear strength between

layers by increasing the strength of the binders used, improving the fiber-matrix interface, and decreasing the porosity of composites make the method frequently unusable. A classification is presented for various types of failure in such materials and a method is suggested for testing, based on the use of shaped specimens with areas of maximum shear stress in the middle portion of the specimens. The method is suitable for carbon, glass, boron, and organic-reinforced plastics. The error introduced by changing the length to thickness ratio is found to be greater, the greater the thickness of the reinforced plate and the less the length to thickness ratio.

References 4: all Russian.

[53-6508]

UDC 620.1:677.5

#### WIRE FOR USE IN COMPOSITE MATERIALS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 4, Jul-Aug 85  
(manuscript received 16 Apr 84) pp 729-730

KLEKOVKIN, A.A., CHUSOV, A.G., KLEKOVKINA, N.A. and OGOLIKHIN, S.A.,  
Beloretskiy Metallurgical Combine; All-Union Institute of Aviation Materials,  
Moscow; Institute of Metallurgy imeni A.A. Baykov, USSR Academy of Sciences,  
Moscow

[Abstract] The requirements which must be met by wire for use in reinforcing materials are noted. Stainless steel type 18Kh15N5AMZ (VNS-9) is primarily used for the purpose. Methods of manufacture of wire include significant compression in the first pass before the metal is hardened, tempering immediately after hardening and drawing of wire with great total deformation. Possible deformation schemes are noted. Very high strength stainless steel wire is widely used in composites with cold-curing adhesives for the manufacture of helicopter main rotor parts and with epoxy resins in the creation of metal-reinforced plastics with great specific strength.

References 4: all Russian.

[52-6508]

## SPECIFICS OF FAILURE OF COMPOSITE MATERIALS BASED ON ARAMID FIBERS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 4, Jul-Aug 85  
(manuscript received 29 Jul 84) pp 736-738

KUZMIN, V.N., ANDREYEV, A.S., DOBROVOLSKAYA, I.P., LELINKOV, O.S.,  
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[Abstract] Organic chemical fibers differ significantly from glass and carbon fibers in usage characteristics. Unidirectional microplastics and circular specimens using untwisted complex PABI (poly-para-amidobenzimidazole) and PFTA (poly-para-phenyleneterephthalamide) fibers in epoxy binder type EDT-10 were studied. The elementary fiber strength realization coefficient was calculated following mechanical testing. Photomicrographs of the fibers are presented. Most typical types of failure include fracture through the fiber for PABI. PFTA frequently failed by adhesion failure, due to the surface interaction of this fiber with EDT-10 binder. Strength utilization factors for PABA fibers were 95-110%, for PFTA fibers--80-85%.  
References 15: 13 Russian, 3 Western.  
[53-6508]

## PRODUCTION OF FILMS WITH PREDETERMINED PHYSICAL-CHEMICAL AND OPTICAL CHARACTERISTICS

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 21, No 9, Sep 85  
(manuscript received 5 Sep 85) pp 1575-1577

FURMAN, Sh.A., LEVINA, M.D., GUSAROV, V.V. and SEMIN, Ye.G.

[Abstract] The composition, structure, and properties of films is studied using fluoride mixtures such as  $MgF_2 + MF_2$ , where M = Ca, Sr, or Ba. Interference films were applied under a vacuum of  $2.7 \cdot 10^{-3}$  Pa. Climatic testing of coatings was performed at 98% relative humidity, at 298 K for 10 days, after holding of the coatings for 10 months in air. The mechanical strength of the thin layers was studied while the concentration of chemical elements was determined by electric discharge microanalysis. The major criteria for selection of vapors for composite materials include a significant temperature range of existence of the liquid phase, a low degree of supercooling of the mixture upon phase transition from liquid to solid, a high rate of exchange reaction between compounds of the components, and near-eutectic composition. References 7: 6 Russian, 1 Western.  
[48-6508]

## STUDY OF NONUNIFORMITY OF LAYER DEFORMATIONS IN CLADDING OF BIMETALS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA  
in Russian No 9, Sep 85 (manuscript received 1 Mar 85) pp 159-160

ARKHANGELSKIY, A.V., KOBELEV, A.G. and BAYDUGANOV, A.M., Moscow Steel and  
Alloys Institute

[Abstract] A mathematical model is suggested for the focus of deformation and analytic equations are derived relating deformation within layers to the basic parameters of the cladding of bimetals for a scheme in which a hard base is covered on both sides by softer metal. The study of the distribution of deformation among layers during the manufacture of multilayer metallic composites yields a mathematical model of the deformation focus and an analytic equation relating the major technical parameters of cladding to the deformation within each layer and allowing prediction of the quality of cold-clad bimetallic rolled products. References 1: Russian.  
[50-6508]

UDC 669.71-131:534.2

## DAMPING PROPERTIES OF GRANULE-BASED COMPOSITE MATERIALS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA  
in Russian No 9, Sep 85 (manuscript received 24 Oct 84) pp 172-173

BRINZA, V.N. and KOLYADINA, Ye.V., Moscow Steel and Alloys Institute

[Abstract] Results are presented from a study of the damping properties of composite materials obtained by pressing a mixture of granules of various aluminum alloys as a function of the relationship of the masses and dimensions of the granules of the various composites. The chemical composition was as follows: alloy #1 -- 3.41% Si, 0.65% total impurities; alloy #2 -- 5.94% Cu, 0.23% Mn, 0.60% Zr, 0.92% impurities. The studies showed that the damping properties of composite materials pressed from granules of aluminum alloys depend on the relationship of the masses of hardening and plastic granules and the relationships of their dimensions in the composite materials. The composite materials studied can be used for the manufacture of parts for cold upsetting machines.  
[50-6508]

## LIFE OF REINFORCED GLASS-PLASTICS

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 21, No 5, Sep-Oct 85 (manuscript received 29 Jun 84) pp 122-124

LEVCHUK, L.I., DELYAVSKIY, M.V. and BAZILEVICH, Z.A., Physical Mechanical Institute imeni G.V. Karpenko, UkSSR Academy of Sciences, Lvov

[Abstract] A study was made of five composite materials consisting of ED-20 epoxy resin as binding base and 60  $\mu\text{m}$  thick glass cloth with satin braiding as reinforcing filler. The respective hardeners were polyethylene polyamine, dicyanethyl diethylene triamine, monocyanethylene triamine, dicyanethyl diethylene triamine + butyl benzyl phthalate, monocyanethylene triamine + butyl benzyl phthalate. Specimens of these materials were tested at 290 K and at 363 K, in air and in water. Analysis of the infrared absorption spectra, with benzene rings, carbonyl groups, and hydroxyl groups as sources of 1605  $\text{cm}^{-1}$ , 1730  $\text{cm}^{-1}$ , and 1380  $\text{cm}^{-1}$  lines, respectively, has revealed a correlation between higher temperature or change of medium and chemical transformations in the polymer material and also a correlation between higher temperature and buildup of carbonyl groups in the polymer material with or without filler. Life calculations were made according to the Zhurkov relation  $\log \tau = \log \tau_0 + U_0 \log \frac{e}{RT} - \gamma \sigma \log \frac{e}{RT}$  ( $\tau_0 = 10^{-13}$  s,

T - temperature,  $U_0$  - activation energy,  $\gamma$  - structural parameter,  $\sigma$  - external load,  $e = 2.72$ ), on the basis of  $U_0$ ,  $\gamma$ ,  $\sigma$  and  $d\sigma/dt$  data obtained by the authors of this study and those already available from other studies. References 3: 2 Russian, 1 Western.  
[78-2415]

UDC 621.51:533.6.013.423

## PERFORMANCE OF STRUCTURES MADE OF COMPOSITE MATERIALS

Kiev PROBLEMY PROCHNOSTI in Russian No 10, Oct 85 (manuscript received 24 Dec 84) pp 12-19

KUZNETSOV, N.D. and STEPANENKO, N.D., Kuybyshev Aviation Institute

[Abstract] Design with composite materials, from the engineering concept to the production process, is illustrated on the example of compressor vanes. Since joints and couplings pose the most difficult problem in the design of any structure, especially where composite materials are involved, parts must not be designed individually but in assemblies. A compressor guide vane, specifically, should be designed with smooth transitions rather than abrupt changes of thickness, with large areas of load transmitting surfaces at the joints, without stress concentrators, and preferably with bilateral



fasteners. Design calculations, generally based on the theory of beams, must include technological constraints as well as geometrical and mechanical ones. Material selection is an important step in the design, to ensure that the distribution of resistance to fracture under flexure, tension, and torsion will be compatible with the stress field in the vane. The required strength and stiffness are usually attainable with a high-modulus filler between two sheaths. Such a sandwich configuration is characterized by a large number of design parameters adjustable for tuning out resonances without affecting the overall dimensions. High fatigue strength requires special reinforcement patterns, with all fibers completely embedded and none terminating at a surface. Strength and stiffness of the edges are the main requisite for high reliability. Coating of the surfaces is desirable, for protection against erosion wear. With all these considerations built into the engineering design, the manufacturing process must be optimized and controlled so as to ensure nondefectiveness of the product. The inspection system and testing procedures must be set up accordingly. References 7: all Russian.

[79-2415]

/13046

## CORROSION

UDC 669.018.7-122.4-156:620.17

### PROPERTIES OF 14Kh17N2 STEEL IN CORROSIVE MEDIA

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA  
in Russian No 9, Sep 85 (manuscript received 10 Jan 85) pp 171-172

ALIMOV, V.I., SHIRYAYEV, V.T. and ONOPRIYENKO, V.G., Donetsk Polytechnical  
Institute

[Abstract] A comparative study is presented of the properties of hot rolled and thermally hardened 14Kh17N2 steel with an imitation of the effects of media and temperature conditions to which the materials are exposed during operation. Specimens 14 mm in diameter and 320 mm long and model specimens with a total length of 300 mm imitating hook and eye joints were tensile tested, while specimens with sharp type 2 notches were tested for impact strength. The strength of hot rolled 14Kh17N2 steel was greater than that of 12Kh18N9T steel. The strength of the model specimens decreased with decreasing test temperature, whereas cylindrical specimens showed a slight increase in strength with decreasing test temperature. References 2: both Russian.  
[50-6508]

UDC 669.293.5:546.34

### CORROSION RESISTANCE OF NIOBIUM ALLOYS IN LITHIUM

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 21, No 5,  
Sep-Oct 85 (manuscript received 3 Apr 85) pp 14-17

IGNATIV, M.I., Physical Mechanical Institute imeni G.V. Karpenko, UkSSR  
Academy of Sciences, Lvov

[Abstract] Corrosion of niobium in liquid lithium and the effect of alloying on its corrosion resistance was studied, other studies having revealed that lithium penetrates niobium when the oxygen concentration in the latter exceeds a certain threshold level. Pure niobium NbPl-1 was tested along with three of its alloys: Nb-Zr-C (NTsU), Nb-W (NV-7), Nb-Zr-W-Mo (5VMTs). All three alloying elements have more affinity to oxygen than niobium and they form thermodynamically stable oxides, zirconium being most active.

Specimens, after heat treatment at 1200-1400°C for 1 h or 2 h under vacuum with residual pressure of  $0.1 \cdot 10^{-3}$  or  $10 \cdot 10^{-3}$  Pa, were soaked in lithium at 700°C for 10-100-1000 h. The oxygen concentration had increased somewhat during preannealing, but metallographic examination revealed no traces of corrosive defects in niobium NbPl-1 and in the 5VMTs alloy. Lithium had penetrated the NV-7 alloy. Increasing the oxygen concentration to 0.019 wt.% by raising the residual pressure during annealing to  $10 \cdot 10^{-3}$  Pa had reduced the corrosion resistance of the NTsU alloy during subsequent soaking in lithium. The theoretical interpretation of these experimental results is based on a model of diffusion accompanied by chemical reaction, rather than on the wedging mechanism. The mode of diffusion depends on the oxygen concentration and on the dispersivity of oxide particles. The governing parameter is the difference between maximum solubility and equilibrium concentration of oxygen, oxide particles breaking up fast or slowly depending on whether this difference is large or small. The thermodynamic criterion for corrosion resistance is, accordingly, that the oxygen concentration in niobium or its alloy do not exceed the equilibrium level. References 12: 9 Russian, 3 Western.  
[78-2415]

/13046

## FERROUS METALS

### NEW MOLDING LINE GOING INTO GORKIY MOTOR VEHICLE PLANT

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 19 Oct 85 p 1

[Article by G. Gundarin, correspondent for GORKOVSKAYA PRAVDA, Gorkiy: "Electronics in the Foundry"]

[Text] Two-thirds of the casting at the Gorkiy Motor Vehicle Plant is done on automatic molding lines which have been put into operation according to a technical retooling plan.

But one often sees this type of neighborhood in a workshop. Alongside the fire-breathing furnaces, the molding lines and buckets with molten metal, a true construction site has developed. Pneumatic drills hammer, truck motors roar under strain, the buckets of an excavator bite into the ground....

"Here yet another automatic molding line is being installed," explains V. Veselovskiy, deputy chief engineer of metallurgical production at GAZ [Gorkiy Motor Vehicle Plant]. "The ninth by count. We decided to place it in operation by the day of the opening of the 27th CPSU Party Congress."

Three years ago the Gorkiy workers required 6 months for installation of the first automatic line. And that was a great achievement. But the experience, skill and growing mastery of the construction workers and installation workers permitted this schedule to be reduced by another 2 months. Veselovskiy and I are walking along a deep foundation pit dividing the shop in two. To our right, within two paces, molding machines are rumbling and dozens of people are busy at the conveyors.

"This is one of the last of the old type of conveyor," Vladimir Evgenyevich continues. "But we can't get along without it for the time being. The program for the output of cast parts remains the same as before during the period for renovating the factory. Therefore we have to do the installation under tight conditions. And here you can't get by without working know-how and courageous engineering decisions."

As an example, it was necessary to replace the foundation under the columns, and the metallurgists proposed that they be suspended above the foundation pit using transverse beams, and they won the time for taking the columns down and installing new ones. An excavator would not pass through the shop's opening,

and workers dismantled it, took it inside the building and assembled it again. The truck drivers carrying earth out laid down a "road" among the equipment and furnaces with a jeweller's precision...

"We have no alternative than to maintain a schedule which is compressed to the limit," says Veselovskiy. "Otherwise, we risk letting down the assembly shops and our subcontractors."

At GAZ's metallurgical shops, hundreds of thousands of tons of iron are smelted annually. More than a thousand parts items, from small couplings to huge crankshafts are delivered to the giant auto maker's assembly conveyor by the metallurgists and are sent to Moscow, Ulyanovsk, Riga and other cities under cooperation agreements.

A decision for retooling this unit was taken at the start of the 11th Five-Year Plan. But not one of the modern molding lines was recorded for the tight, squat buildings of the shops. The motor vehicle plant's specialists developed, designed and manufactured their own design, one which is reliable, compact and increases casting precision while reducing labor costs.

We observed these lines at work in the neighboring shops. The molds moved for casting, passed through the cooling zone and then the castings were separated from the molding sand along a continuously moving closed line, while the molds themselves were sent back for remolding.... And all of this without the participation of man for practical purposes. Electronics follows the operations, and various mechanisms and manipulators have taken on the labor-intensive operations.

Labor productivity grows by a factor of 2-4 times with the incorporation of each such line, waste is cut almost in half, and the weight of the castings, which now require little mechanical working, is reduced. And, most importantly, 30-60 persons are liberated. As a result of the incorporation of automatic lines the auto workers here have freed 750 persons in these sectors.

Soon automatic molding lines will completely replace the old conveyors. Will the retooling be done with this?

"Of course not," answered V. Churayev, administrator for metal production at GAZ. "In that very same foundry shop #5, where installation of the ninth automatic line is under way, and, by the way, where we are completing the adjustments on the eighth, we are testing a new plasma arc furnace. The results of the first smelt give us hope. In the future these ecologically clean ones will replace the ordinary type. And there plans in connection with preparation for production of a new truck, a tractor-trailer rig with diesel engine."

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CSO: 1842/55

## NEW PROCESS DISCOVERED TO REDUCE COKE CONSUMPTION

Moscow PRAVDA in Russian 21 Oct 85 p 1

[Article by N. Makharinets, free-lance correspondent for PRAVDA: "It Will Be of Service to Metallurgists"]

[Text] Smelting using reducing gases and oxygen, without blast of atmospheric air, has been started at one of the furnaces of the Tulachermet scientific production association. The new technology will permit consumption of scarce coke to be reduced in the blast furnace process.

This event was preceded by years of creative searches by scientists and engineers. As a result, the researchers proposed that purified blast furnace gas be used as an intensifier for the iron smelting process. It is now being burned at many enterprises in their boiler-rooms to provide room heating. But, as it turned out, it can be of benefit to the metallurgists themselves if this gas has reducing properties imparted to it, having the ballast, the carbon dioxide, removed from it and is blown into the furnace together with oxygen. The experimental-industrial complex established in Tula serves as a concrete example of the embodiment of the project.

"It includes," chief engineer of the Tulachermet association M. Boyko informed us, "operating furnace #2, as well as the newly constructed compressor station, an automated gas cleaning installation, a large-diameter piping network and other structures. The distinctive feature of the complex is that the metallurgical and chemical parts are combined in a single technological chain."

Now at furnace #2, the exhaust blast furnace gas is sent by pipe not to the TETs [Heat and Electric Power Station] as before, but are passed through a compressor and fed at a pressure of several atmospheres to a special installation not far away, where the carbon dioxide is removed. Then the gas is heated up to a temperature of more than 1,100° and forced in this state into the furnace. It is here that industrial grade oxygen is also fed in.

In the opinion of specialists, use of this method will permit coke consumption in the blast furnace process to be reduced by 20 percent and more, productivity of the metallurgical units to be noticeably increased and the production costs of the product to be reduced.

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CSO: 1842/55

UDC 621.771.22

COMBINED APPROACH TO SOLUTION OF PROBLEM OF INCREASING QUALITY OF SPECIAL  
STRIP STEEL TYPE 55S2

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA  
in Russian No 9, Sep 85 (manuscript received 4 Jun 84) pp 107-109

MACHIKIN, V.I., Deceased, MINAYEV, A.A., KHARCHENKO, A.V. and  
ONITSENKO, S.A., Donetsk Polytechnical Institute

[Abstract] The tool elements of agricultural equipment made of type 55S2 strip spring steel do not satisfy the requirements placed upon them and fail sooner than they should, primarily due to the presence of stress concentrators which induce the development of fatigue cracks. Both external and internal stress concentrators are found in these parts. The authors have established the antidisjunctive nature of the influence of internal and external stress concentrators on the fatigue durability of tools. High fatigue durability cannot be achieved if either type of stress concentrator is present. This requires a combined approach to the problem of increasing the quality of the steel. A single combined criterion is developed which unifies a group of factors to yield single evaluation of steel quality. Maximizing this criteria makes it possible to determine the optimal content of alloying elements in 55S2 steel, its optimal heat treatment and most effective cross-section of strip profiles, consisting of curves of variable curvature. References 3: all Russian.  
[50-6508]

UDC 669.27'28-143-157.97:620.18

STRUCTURE AND PROPERTIES OF CAST TUNGSTEN-MOLYBDENUM AND MOLYBDENUM  
HIGH-SPEED STEELS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA  
in Russian No 9, Sep 85 (manuscript received 24 Jan 85) pp 118-121

POPANDOPULO, A.N., KALININA, V.I. and SMIRNOV, A.A., Leningrad Polytechnical  
Institute

[Abstract] A study is made of low-alloy cast molybdenum high-speed steel types E1260 (ROM3F2) and E1277 (ROM2F3) in comparison to tungsten-molybdenum



steel R6M5. The steel was made in a high frequency induction furnace and poured in a water-cooled metal chill mold. The rapid cooling rate results in a fine grained structure. The steels are found to be equal in hardness, red hardness, and long-term strength to R6M5 steel. Low alloy tungsten-free cast steels have lower hot hardness than R6M5, resulting in short service life when cutting difficult-to-work materials at high speeds. Low alloy steels can operate reliably when cutting difficult-to-work materials if the cutting edge remains below 400°C. References 10: all Russian. [50-6508]

UDC 669.017:668.15:669.778

INTERNAL MICROSTRESSES AS CAUSE OF HIGHER STARTING TEMPERATURE OF  
MARTENSITE TRANSFORMATION DURING ELECTROLYTIC HYDROGENATION OF AUSTENITE

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 21, No 5,  
Sep-Oct 85 (manuscript received 13 Feb 84) pp 26-28

TKACHENKO, I.M., BASHNIN, Yu.A., SARRAK, V.I. and SUVOROVA, S.O.,  
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[Abstract] Hydrogenation of austenitic alloys by the electrolytic process is known to shift the temperature at which martensite transformation starts upward, but the causes and mechanism of this change are not yet sufficiently well understood. In search of an explanation, the N31 low-carbon 31.5% Ni+ 0.012% C iron-nickel alloy was studied. The low carbon content practically eliminated its effect on the  $M_s$ -point, allowing hydrogenation at room temperature with retention of a sufficient amount of diffusionally transportable hydrogen for measurements. Specimens of the alloy were heated to 1050°C and then water-cooled to room temperature. With a thus acquired purely austenitic structure, according to subsequent x-ray diffraction analysis, they were hydrogenated for 24 h in a solution of 0.25N  $H_2SO_4$  + 200 mg/l  $SeO_2$  at various current densities within the 5-1750 A/m<sup>2</sup> range. The concentration of diffusionally transportable hydrogen was measured immediately after each run and the  $M_s$ -point was determined from the temperature dependence of internal friction, the latter being measured with an "inverse torsional pendulum" relaxator at a frequency of 1.12 Hz. The resistance to microplastic deformation, characterized by the strain amplitude corresponding to the threshold of irreversible increase of internal friction, was determined from the amplitude dependence of the latter. The dependence of the  $M_s$ -point on the saturating current density was found to be nonmonotonic, with a sharp peak within the 50-150 A/m<sup>2</sup> range and with the concentration of diffusionally transportable hydrogen also becoming maximum at the same current density. Accordingly, the upward shift of the  $M_s$ -point correlates only with diffusionally transportable hydrogen and not with defectiveness produced by hydrogenation. The trends of internal friction and resistance to microplastic deformation indicate that not dissolution of hydrogen in the austenite lattice but buildup of internal microstresses in the lattice causes this change. References 2: 1 Russian, 1 Western. [78-2415]

## STABILITY OF POLYGONAL STRUCTURE CREATED BY HEAT AND MECHANICAL TREATMENT OF 12Kh1MF STEEL

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian  
No 10, Oct 85 pp 17-20

IVANOVA, V.S., FRIDMAN, Z.G., KOGAN, I.S., MOZHARENKO, I.P., Metallurgy  
Institute imeni A.A. Baykov; All-Union Scientific Research and Design-  
Technological Institute of the Pipe Industry, Dnepropetrovsk

[Abstract] A study was made of the stability of polygonal structure in 12Kh1MF steel obtained by heat and mechanical treatment, which consists of deformation of the metal to 8-13% with subsequent polygonization annealing in the subrecrystallization temperature interval. The metal was tested over long-term operation in industrial power systems. The metal was also tested for its resistance to thermal effects upon contact welding by microstructural analysis of the heated zone round a welded seam. Studies of the dislocation structure of the steel were performed on a transmission electron microscope. They showed that the structure of the steel in the initial state features homogeneous distribution of dislocations through the volume of the metal. After heat and mechanical treatment but before usage, subrecrystallization annealing at 600°C for 10 hours was found to cause partial annihilation of dislocations. After 100,000 hours of use, the polygonal structure was found to be stable, basically preserved after long-term operation. Continued development of recovery and decreased density of dislocations in the internal volumes of subgrains were observed. Heat and mechanical treatment was thus found to yield a substructural hardening which is preserved over long-term use in boilers at 500-600°C and near welded seams. References 7: all Russian.  
[54-6508]

UDC 539.434:669.26'71'782'296

## INFLUENCE OF ZIRCONIUM ON HEAT RESISTANCE OF SICHROMAL TYPE STEEL

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian  
No 10, Oct 85 pp 36-39

RYABCHENKOV, A.V., TARZHUMANOVA, V.A. and YUGANOVA, S.A., Scientific-  
Production Association, Central Scientific Research Institute of Machine  
Building Technology

[Abstract] Studies of sichromal steel 03Kh8SYu containing up to 0.91% Zr showed that the introduction of zirconium at 0.47-0.91% helps to increase heat resistance of the steel at 900°C. The decrease in mass ( $\Delta m$ ) of specimens after 500 hours of testing at 900°C was only 1.5 mg/cm<sup>2</sup>, whereas for the initial steel and steel with the addition of smaller quantities of

zirconium,  $\Delta m \approx 8 \text{ mg/cm}^2$ . This article presents results of subsequent studies in the same area with 0.05-2.25% Zr added to the same steel, produced in a 50 kilogram induction furnace with subsequent pouring into 12 kg ingots which were forged at 1150-850°C to produce 13 mm diameter billets. Cylindrical specimens 10 mm in diameter and 15 mm long were tested in air at 900°C for a maximum of 4500 hours to determine heat resistance. For all steels tested the corrosion rate decreased with time, particularly in specimens containing zirconium. The most effective was 0.40-0.70% Zr. Higher contents of zirconium resulted in internal oxidation. The increase in heat resistance of the zirconium-containing steel was related to the formation of a surface film which contained  $\text{Al}_2\text{O}_3$ . References 4: 2 Russian, 2 Western.  
[54-6508]

UDC 669.14.018.298.2

#### CASE-HARDENABLE STEEL 16Kh2N3MFBAYu-Sh

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian  
No 10, Oct 85 pp 61-63

UTKINA, A.N., BANAS, I.P., TARASENKO, L.V., KOZLOV, V.L. and RUKINA, I.M.

[Abstract] The steel 16Kh2N3MFBAYu-Sh (VKS7-Sh) has the following chemical composition: 0.14-0.19% C, 1.8-2.2% Cr, 2.7-3.0% Ni, 0.4-0.6% Mo, 0.1-0.2% V, 0.1-0.2% Nb, 0.02-0.07% Al, 0.015-0.03% N. To assure optimal content of carbon in the surface layer and favorable shape of segregated carbides, the steel should contain not over 2.2% Cr and 2.7-3.0% Ni. If the Ni content is 2.0-2.5%, there is a danger of supersaturation of the cemented layer with carbon upon long-term case hardening. At over 3% nickel, the carbide phase is segregated as a grid along grain boundaries. The steel contains small quantities of surface-active elements Mo, V, and Nb, resulting not only in the formation of globular carbides, but also in a delay in the growth of the grain upon case hardening at up to 950°C. This new steel has significant advantages over 12Kh2N4A, including smaller grain, greater fatigue resistance, and contact durability. The steel is no more expensive than 12Kh2N4A and less expensive than 18Kh2N4VA.  
[54-6508]

/13046

## NONFERROUS METALS AND ALLOYS; BRAZES AND SOLDERS

### SYSTEM CONSIDERED TO EXPAND ENTERPRISE CONTROL OF OPERATIONS

Moscow PRAVDA in Russian 17 Oct 85 p 2

[Article by P. Lomako, USSR Minister of Nonferrous Metallurgy: "Expanding the Rights of Enterprises"]

[Text] The USSR Ministry of Nonferrous Metallurgy examined the article "The Right to Decide," published 10 Aug 1985, and considers that it raises questions concerning shortcomings in industrial enterprise management which paralyze the initiative of labor collectives with superfluous instructions and directives correctly and in a timely fashion.

Presently proposals are being worked out at the ministry for conversion to what is basically a two-link administration system which will permit more flexible administration of scientific-production and production associations and enterprises, and expand their rights and independence. In line with this, a significant reduction in the administrative apparatus is being called for.

Beginning 1 January 1986 enterprises of USSR Ministry of Nonferrous Metallurgy will be shifted over to the new management conditions. In connection with this action, concrete measures are being taken by the ministry to propagate management methods intended to accelerate scientific and technical progress, raise the responsibility of the enterprises for fulfillment of the plan for production and delivery of their product and reinforcing performance discipline. In particular, the problem of completing a large number of operations connected with reoutfitting plants and preparation of the enterprises for fulfilling the intensive plan of the 12th Five-Year Plan has been posed for the collective of the Norilsk combine.

The ministry is examining the possibility of reducing the number of plan indicators which are confirmed for the enterprises. Thus, the output of the Norilsk combine which is consumed within the enterprise (sulfuric acid, brick, cement etc.) has now been shifted from the category of being confirmed to accounting items. These types of products will be taken into consideration only when determining the demand for material and technical resources and their production throughout the national economy as a whole.

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CSO: 1842/55

ZAPOROZHYE TITANIUM-MAGNESIUM PLANT OVERFULFILLS PLAN AHEAD OF SCHEDULE

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 18 Oct 85 p 1

[Article by O. Dmitriyev, Zaporozhye: "The Metallurgists' Report"]

[Text] The Zaporozhye Titanium-Magnesium Combine's collective staff reported the completion of the program for the 11th Five-Year Plan ahead of schedule. By the end of the year, the Zaporozhye metallurgists will provide above-plan production in the amount of tens of millions of rubles.

In the enterprise's shops there is constant renovation of machinery and technology, mechanization and automation equipment is being introduced and working conditions are being improved. All of this promotes the achievement of high labor indicators. Among those forerunners in the competition in honor of the 26th CPSU Party Congress are furnace worker brigade-leader and deputy of the USSR Supreme Soviet, Hero of Socialist Labor V. Zhilovskiy, honored metallurgist of the UkSSR and furnace worker V. Bogma and V. Baranets, laureate of the USSR State Prize.

9194

CSO: 1842/55

UDC 541.123.24:621.187.1

FORMATION OF SOLID SOLUTIONS IN NICKEL-CHROMIUM VACUUM CONDENSATES

Kiev DOKLADY AKADEMII NAUK SSR, SERIYA B: GEOLOGICHESKIYE KHIMICHESKIYE I BIOLOGICHESKIYE NAUKI in Russian No 9, Sep. 85 (manuscript received 8 Apr 85) pp 35-37

BATALIN, G.I., KAPITAN, A.V., KUSHKOV, V.D. and MELNIKOV, A.V., Kiev State University imeni T.G. Shevchenko

[Abstract] A study is presented of the influence of condensation temperature on the phase composition of vacuum condensates in the Ni-Cr system over a broad range of concentrations of the components. Massive condensates of variable compositions were obtained by simultaneous evaporation of individual high purity metals, condensation of the vapor phase occurring at 150-170  $\text{nm}\cdot\text{s}^{-1}$  on a substrate heated to constant temperature with a 20.0  $\mu\text{m}$  sublayer of zirconium dioxide previously applied. Condensates were obtained in the 500-1100°C interval. The experiments established that the vacuum condensates, depending on the content of the components, are represented by two solid solutions based on nickel and chromium. Radiographic studies revealed that throughout the range of compositions and temperatures studied there is a clear preferential orientation of the crystals in the specimens formed. The use of separate evaporation of individual metals with subsequent joint condensation allowed a study to be made of the phase composition of condensates in the Ni-Cr system over a broad range of concentrations. Boundaries of existence of solid solutions in the condensates were determined. References 12: 3 Russian, 9 Western. [60-6508]

UDC 546.812.23-24

DIFFUSION OF GALLIUM IN  $\text{Pb}_{0.8}\text{Sn}_{0.2}\text{Te}$  AND  $\text{PbTe}_{0.92}\text{Se}_{0.08}$  SOLID SOLUTIONS

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 21, No 9, Sep 85 (manuscript received 15 Feb 84) pp 1473-1475

SIMIRSKAYA, G.P. and FIRSOVA, L.P., Moscow State University imeni M.V. Lomonosov

[Abstract] Diffusion was studied by the radioactive indicators method with the isotope  $^{67}\text{Ga}$  applied to the surface of specimens as gallium chloride or

citrate. The specimens studied were cut from single crystals grown by a vapor-liquid-crystal mechanism. Before diffusion annealing the specimens were ground and polished in an  $\text{HBr}:\text{Br}_2$  mixture (50:1). The  $\text{PbTe}_{0.92}\text{Se}_{0.08}$  specimens used to study the diffusion coefficient of gallium as a function of partial pressure of lead vapor were subjected to prediffusion annealing at fixed temperature and component vapor pressure. The concentration profiles of the  $^{67}\text{Ga}$  diffusing into the  $\text{Pb}_{0.8}\text{Sn}_{0.2}\text{Te}$  and  $\text{PbTe}_{0.92}\text{Se}_{0.08}$  solid solutions were found to have two components corresponding to slow and fast migration. Equations were obtained for the variation of the diffusion coefficient of gallium in the two solid solutions as a function of temperature. The activation energy was found to be 0.33-0.38 eV. The diffusion coefficients of gallium in  $\text{PbTe}_{0.92}\text{Se}_{0.03}$  at 920 K depend little on partial pressure of lead vapor in the process of diffusion annealing. References 7: 6 Russian, 1 Western.  
[48-6508]

UDC 669.018.45:620.181

#### STRUCTURAL CHANGES UPON SHORT TERM LOADING OF HEAT RESISTANT NICKEL-BASED ALLOYS

Moscow IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: CHERNAYA METALLURGIYA  
in Russian No 9, Sep 85 (manuscript received 3 Sep 84) pp 110-112

MEDVEDEV, V.V., SAZONOV, Yu.B. and KONSTANTINOVA, S.A., Moscow Steel and Alloys Institute

[Abstract] A study was made of structural changes, including mean particle diameter and interparticle distance of the major hardening  $\gamma'$ -phase, occurring in heat resistant deformable alloys such as EI437A, EP454, EP742, and EP109VD when suddenly heated to above the design temperature. Heating was performed by direct transmission of electric current at standard line frequency through specimens in the clamps of a test machine. In EI437A, increasing overheating to more than 100 K leads to enlargement of particles, an increase in the distance between particles, and dissolving of the hardening  $\gamma'$ -phase. In EP454 the  $\gamma'$ -phase particle enlargement also occurs. Coagulation of  $\gamma'$ -phase particles in EP742 and EP109VD was not observed, apparently as a result of the influence of cobalt, molybdenum, and niobium. In all alloys, secondary  $\gamma'$ -phase segregation occurred upon cooling. References 5: all Russian.  
[50-6508]

HEAT TREATMENT OF FOIL OF Ti-Al-V SYSTEM ALLOYS OBTAINED BY VACUUM  
PRECIPITATION

Moscow IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: CHERNAYA METALLURGIYA  
in Russian No 9, Sep 85 (manuscript received 20 Apr 83) pp 112-115

ULANOVSKIY, Ya.B., SKAKOV, Yu.A. and DUBNIK, G.L., Moscow Steel and Alloys  
Institute

[Abstract] The purpose of this work was to study the influence of heat treatment on the structure and properties of foil made of Ti-3Al-2V and Ti-6Al-4V alloys obtained by vacuum precipitation. The microstructure of the foils before and after annealing at 850°C for one hour was studied. Vacuum annealing causes significant growth in size and change in shape of crystals. The surface of the foil is smoothed in this process. Foil of two phase  $\alpha+\beta$  alloy Ti-6Al-4V was obtained at low temperature by condensation onto a substrate of stainless steel and molybdenum as the structure of a super-saturated  $\alpha$ -titanium solution. During high temperature annealing, the  $\beta$ -phase is segregated along the boundaries of the initial  $\alpha$ -titanium grains. The coefficient of normal anisotropy of plasticity is increased by annealing. References 3: all Russian.  
[50-6508]

## THERMAL DIFFUSIVITY OF TITANIUM ALLOYS IN SOLID AND LIQUID STATES

Moscow TEPILOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 23, No 5, Sep-Oct 85  
(manuscript received 11 Oct 84) pp 890-893

POLEV, V.F., ZINOVYEV, V.Ye. and KORSHUNOV, I.G., Sverdlovsk Mining Institute

[Abstract] The thermal diffusivity of five commercial titanium alloys OT4 (3.5% Al), VT20 (6.0% Al + 2.0% Zr + 1.0% Mo + 1.0% V), VTZ-1 (6.0% Al + 2.5% Mo + 0.3% Si + 2.0% Cr + 0.5% Fe), VT8 (6.5% Al + 3.3% Mo + 0.3% Si), VT9 (6.5% Al + 1.5% Zr + 3.3% Mo + 0.25% Si) and of monocrystalline titanium was measured over the 1000-2000 K temperature range covering both solid and liquid states. Measurements were made under a vacuum of  $10^{-3}$  Pa, with combined harmonic and fast linear heating of flat specimens continuously at an average rate of approximately 50 K/s so that an experiment had to be completed within 20-30 s. The average temperature of specimens was recorded by a VR5/VR20 thermocouple with the hot electrode 50  $\mu$ m in diameter and temperature fluctuations were recorded by an FD-10G photodetector covering a spot 3 mm in diameter at the center of a specimen. It had been established experimentally that at the instant of melting a specimen became liquid but retained its shape for a period of time ranging from a few tens of milliseconds to a few tenths of a second, which facilitated measurement of thermal



diffusivity ranging from tens to hundreds of  $\text{m}^2/\text{s}$ . The overall measurement error did not exceed 4%. The results reveal that an  $\alpha \rightarrow \beta$  phase transformation in monocrystalline titanium is accompanied by a step increase of its thermal diffusivity. The temperature dependence of thermal diffusivity in the case of VTZ-1, VT8, VT9 alloys indicates an  $(\alpha + \beta) \rightarrow \beta$  phase transformation within the 1000-1300 K range. In the  $\beta$ -phase range the thermal diffusivity of all five alloys follows closely the diffusivity polytherm of pure titanium. During melting, however, the thermal diffusivity decreases in the case of VTZ-1, VT8, VT9 alloys and increases in the case of OT4, VT20 alloys. This difference in behavior is not yet understood, but the high Mo and Si content in the first three alloys may be a factor. Figures 2; tables 3; references 6: all Russian.

[80-2415]

UDC 620.17.18:669.292

#### CHANGES IN STRENGTH AND RECRYSTALLIZATION OF VANADIUM AND ITS ALLOYS

Kiev FIZIKO-KHIMICHESKAYA MEKhanika MATERIALOV in Russian Vol 21, No 5, Sep-Oct 85 (manuscript received 27 Apr 84) pp 3-6

MAKSIMOVICH, G.G., LYUTYY, Ye.M., KALYANDUK, V.N. and PERESICHANSKIY, M.A., Physical Mechanical Institute imeni G.V. Karpenko, UkSSR Academy of Sciences, Lvov

[Abstract] A study of two vanadium alloys, V + 2.6% Zr + 0.36% C and V + 10.5% Nb + 1.9% Zr + 0.17% C, as well as of pure vanadium VnP1-1, was made for determining the effect of combined solid solution and dispersion hardening on their recrystallization temperature and heat resistance. Mechanical tests in a radial 6-position tensile machine were performed on 10 mm long and 3 mm wide specimens of 1 mm thick cold-rolled sheet, punched in the direction of rolling and filed, then annealed at temperatures of 300-1200°C for 1 h at each temperature under a residual pressure of  $13.3 \cdot 10^{-3}$  Pa. The specimens were elongated at a rate of  $0.05 \text{ mm/s}^{-2}$  to an approximately 70% final deformation. A subsequent x-ray phase analysis revealed zirconium carbide with an f.c.c. crystal lattice in both alloys, approximately 2.5 times more in the V-Zr-C alloy than in the V-Nb-Zr-C alloy, and traces of vanadium carbide with a c.p.h. crystal lattice in both. Metallographic examination and x-ray diffraction analysis with microhardness measurements using a 0.49 N load have revealed that recrystallization starts at 900°C. Annealing at that temperature was found to decrease the microhardness and thus the strength, also causing recrystallization to continue at higher temperatures. Within the critical range of percent deformation, accordingly, recrystallization of complex vanadium alloys is regulated by precipitation of zirconium carbide, its morphology and distribution, as well as by the thermal stability of precipitated vanadium carbide. References 10: 7 Russian, 3 Western (1 in Russian translation).

[78-2415]

## EFFECT OF ALLOYING WITH ELEMENTS OF SUBGROUPS IV,V,VI ON OXIDATION OF VANADIUM DURING HEATING IN AIR

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 21, No 5, Sep-Oct 85 (manuscript received 5 May 84) pp 6-8

SHIROKOV, V.V., VENGRENOVICH, R.D., KASYAN, I.M. and STEPANISHIN, V.I., Physical Mechanical Institute imeni G.V. Karpenko, UkSSR Academy of Sciences, Lvov

[Abstract] Oxidation of vanadium in alloys with elements of subgroups IV,V,VI was studied, this oxidation becoming catastrophic at temperatures above 873 K with formation of liquid  $V_2O_5$  in the film and subsequent scale formation - an obstacle to thermomechanical treatment not only in air but also in protective atmospheres. The three groups of alloys tested were V + 3 wt.% Zr + 0.37 wt.% C, V-Nb-Zr-C (1.3-15 wt.% Nb) and V-Mo-Zr-C (2-3 wt.% Mo), with pure vanadium VnM-2 as reference material. Specimens were heated in air to 1273 K at a rate of 10 degree/min and examined with a Paulik "Q" derivatograph. Aluminum oxide, not undergoing polymorphic or phase transformation up to that temperature, served as the standard. An analysis of the derivatograms reveals that pure vanadium is least resistant to oxidation, remaining stable up to 523 K but already oxidizing intensely at 737 K with appearance of  $V_2O_5$  in addition to VO and  $V_2O_3$ . The relatively stable alloy V-Zr-C was found to generally lose heat resistance upon addition of niobium or molybdenum, only the V + 6% Nb + 3.4% Zr + 0.32% C + 0.6% Al alloy and the V + 2% Mo + 2.6% Zr + 0.3% C alloy being able to retain it. References 5: 1 Russian, 4 Western (1 in Russian translation). [78-2415]

UDC 669.293.5:539.143

## ENDURANCE OF PT3V TITANIUM ALLOY AT ELEVATED TEMPERATURES

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 21, No 5, Sep-Oct 85 (manuscript received 26 Apr 85) pp 9-11

KALAKHAN, O.S., YAREMCHENKO, N.Ya. and PREVARSKAYA, N.A., Physical Mechanical Institute imeni G.V. Karpenko, UkSSR Academy of Sciences, Lvov

[Abstract] A study of the PT3V pseudo- $\alpha$  (with  $\beta$ -phase successor) Ti-Al-V alloy was made for determination of its endurance at temperatures up to 623 K. Smooth specimens and specimens with a stress concentrator (notch with 0.1 mm radius) were tested for fatigue in pure flexure with rotation at a loading frequency of 50 Hz at 293-473-623 K, with  $2 \cdot 10^7$  cycles as reference base. The results reveal a sharp decrease of endurance with rising temperature and no distinct endurance limit at 623 K for smooth specimens

and at 473 K and 623 K for those with stress concentration. While the allowable stress level for reaching the base of  $2 \cdot 10^7$  cycles was 37% lower at 623 K than at 293 K, under low stresses with the same overstress above  $\sigma_{-1}$  the life was found to become longer at higher temperature. Metallographic and fractographic examinations of specimens with stress concentration revealed a hybrid fracture mode at 293 K, dominant brittle fracture at 473 K, and pure ductile fracture at 623 K. In the case of smooth specimens the cracking rate was found to increase with higher temperature, characterized by increasing concentration but decreasing length of fatigue striae along with a change from purely ductile striation at 293 K to additional intergranular cleavage at 473 K and intergranular microductile fracture at 623 K. References 7: 5 Russian, 2 Western.  
[78-2415]

UDC 669.295.017:621.78.061.9:620.355

# SURFACE RELIEF OF TITANIUM-ALLOY SHEETS HEATED IN VACUUM AND ITS DEPENDENCE ON HEATING TEMPERATURE

Kiev FIZIKO-KHIMICHESKAYA MEKhanika MATERIALOV in Russian Vol 21, No 5, Sep-Oct 85 (manuscript received 6 Feb 84) pp 12-14

SHEVCHENKO, V.V., LOBANOVA, N.N. and IVANISHCHEVA, G.A., Moscow Aviation Technological Institute imeni K.E. Tsiolkovskiy

[Abstract] Vacuum heating of four titanium alloys (VT-0, VT5, VT6, VT15) in sheet form was studied for determination of the temperature dependence of their surface roughness. One surface of the 2-3 mm thick specimens was mechanically polished prior to annealing, whereupon they were heated with dynamic rarefaction to  $1.2 \cdot 10^{-3}$  Pa at temperatures from 700°C to 1200°C and held for 1 h at each temperature. They were then cooled in the furnace down to 120-100°C and only then exposed to air. An analysis of the profilograms has revealed a nonmonotonic temperature dependence of the height of both intragranular and intergranular microasperities, with sharp maxima at a temperature which depends on the phase composition of the material and thus whether it is below or within the  $\alpha \rightarrow \beta$  or  $(\alpha + \beta) \rightarrow \beta$  transformation range. Dehydrogenation, sublimation of titanium and evaporation of alloying elements, and absorption of residual gases from the ambient medium play a role in changing the mass of material and in shaping the surface relief. Evaporation of molybdenum, for instance, is so much slower than sublimation of titanium that the molybdenum concentration reaches a level at which it interacts with the residual atmosphere and forms a fusible  $\text{MoO}_3$  film. Residual oxygen and carbon change the chemical composition of the surface material, whether they form oxide and carbide films on the surface at lower annealing temperatures or diffuse deeper below the surface at higher annealing temperatures. References 5: all Russian.  
[78-2415]

## FAST HEATING OF VT23 TITANIUM ALLOY FOR REDUCING DETRIMENTAL GAS SATURATION DURING HEAT TREATMENT

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 21, No 5, Sep-Oct 85 (manuscript received 29 Jun 84) pp 105-107

IVASISHIN, O.M., OSHKADEROV, S.P. and POLATAY, V.M., Metal Physics Institute, UkSSR Academy of Sciences, Kiev

[Abstract] Fast heating of the VT23 titanium alloy for reducing the detrimental effects of gas saturation was studied, an indication of the effectiveness of such a heat treatment being the attendant structural changes especially with regard to the surface layer. Specimens having initially a fine-grain structure were air-heated to 1033-1223-1373 K, continuously at constant rates ranging from 0.17 to 75 K/s<sup>-1</sup>. The degree of gas saturation was determined from the thickness and the relative microhardness of the surface layer and also from the increment of electrical resistance. The latter is equivalent to the increment of mass and caused by reduction of the effective cross-sectional area during scale formation, as well as by the lower electrical conductivity of the gas-bearing layers. The distributions of alloying elements (Fe, Cr, Al) were determined with the aid of an MS-46 scanning microanalyzer measuring and averaging their concentrations, the nonuniformity of their distributions being caused by their different solubilities in the  $\alpha$ -phase and in the ( $\alpha+\beta$ )-phase. Phase analysis and the concentration profiles have revealed that raising the temperature from 1033 to 1373 K deepens the zone of alloy concentration nonuniformity from 30 to 100  $\mu\text{m}$ , which is still much less than the 300-600  $\mu\text{m}$  depth of oxygen penetration resulting in a higher microhardness. An increase of the heating rate decreases the case thickness and, to a lesser degree, increases the relative surface microhardness. Heating at a rate of 75 K/s reduces the thickness of the gas-bearing layer to a metallographically almost unmeasurable dimension. Fast heating to 1033 or 1223 K did not noticeably change the chemical composition of the surface layer. Fast heating to 1373 K made this change analytically detectable, with aluminum segregating as much as during slow heating to 1033 K. Fast heating did not change the distribution of  $\beta$ -phase stabilizing elements qualitatively but only increased their concentration at some depth and decreased that depth. References 3: all Russian.

[78-2415]

## INFLUENCE OF MOLYBDENUM, TUNGSTEN, AND COBALT ON CORROSION OF NICKEL HIGH TEMPERATURE ALLOYS IN SALT MELTS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian  
No 10, Oct 85 pp 21-25

ORYSHICH, I.V. and KOSTYRKO, O.S., Casting Problems Institute, Ukrainian Academy of Sciences

[Abstract] A study was made of the influence of the addition of molybdenum, tungsten, and cobalt on resistance to sulfide and chloride corrosion of heat-resistant nickel alloys ZhS6K, EP539, and EP958. Specimens were corrosion tested in sodium sulfate (75%  $\text{Na}_2\text{SO}_4$  + 25% NaCl) and sodium chloride (at  $t > 800^\circ\text{C}$  -- 100% NaCl, at lower temperatures -- 50% NaCl + 50% KCl) melts. The corrosion resistance was evaluated based on the mean rate of mass loss of the specimens in grams per square meter per hour after hot etching in an alkali, sodium nitrate, and sodium chloride melt at  $450^\circ\text{C}$  for 0.5-1 hr. The addition of molybdenum, tungsten, and cobalt to the nickel alloys was found to increase sulfide corrosion while decreasing chloride corrosion. Molybdenum and tungsten must be introduced in quantities determined by the content of chromium in the melts in order to assure good resistance to sulfide corrosion:  $\Sigma\text{Mo+W}$  at 25% Cr not over 12%, at 18% Cr not over 8%, at 10% Cr not over 1.5%. References 11: 7 Russian, 4 Western.  
[54-6508]

## STRUCTURAL CONVERSIONS UPON HEATING OF HEAT-RESISTANT CAST NICKEL ALLOY KhN62MKVBTYu

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian  
No 10, Oct 85 pp 26-28

VEKSLER, Yu.G., MASLAKOVA, T.M., LESNIKOV, V.P., KUKHTIN, M.V. and BOGAYEVSKIY, V.V., Urals Polytechnical Institute, Uralmash Production Association

[Abstract] A study is presented of the structural conversions in cast KhN62MKVBTYu heat-resistant nickel-based alloy (0.10-0.15% C, 17-19% Cr, 4-6% Co, 4.5-6.5% Mo, 2-3% Ti, 3-4% Al, 2.5-4% W, <2.5% Fe, 1.4-2% Nb, 0.5% Mn, 0.04-0.12% B,  $\leq 0.010\%$  S,  $\leq 0.015\%$  P,  $\leq 0.5\%$  Si) upon heating to  $950-1275^\circ\text{C}$  of the processes of dissolution of the hardening  $\gamma'$ -phase and of changes in its parameters as a function of heating temperature. Studies were performed on two specimens in two initial states: after homogenizing annealing at  $1170^\circ\text{C}$  for 3.5 hr in argon and after aging at  $900^\circ\text{C}$  for 100 hr. Processes occurring upon heating were studied after sudden cooling in 10%

NaOH solution in water from 950-1275°C. It was found that the temperature of dissolution of the  $\gamma'$ -phase of the alloy is approximately 1100°C and the temperature of the nonequilibrium solidus is about 1200°C. This results from the presence of carbide eutectic and the multicomponent nature of the system. References 4: all Russian.  
[54-6508]

UDC 669.245

#### BORIDE PHASES IN NICKEL-BASED ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian  
No 10, Oct 85 pp 28-30, 35

PIGROVA, G.D., Scientific-Production Association, Central Scientific Research and Planning-Design Boiler-Turbine Institute imeni I.I. Polzunov

[Abstract] A study was made of boride phases formed in nickel-based alloys EI826, EI827, EI929, EP220, EI617, EI893, EP539, EI661, EI867, and EI109, containing 0.005 to 0.02% B. Alloys were studied after heat treatment and long-term aging at 600-900°C. Borides were also studied in three experimental alloys: 1) 21.8% Cr, 4.6% W, 0.9% B, remainder nickel; 2) 22.3% Cr, 8.3% W, 1.0% B, remainder nickel; and 3) 18.5% Cr, 9.3% W, 0.07% B, remainder nickel. The method of physical-chemical phase analysis was used. It was found that characteristic boride phases in complex nickel-based alloys were M3B2 and M5B3. Various boride phases were present, depending on the content of chromium, molybdenum, and tungsten in the alloys. In alloys in which two types of borides were present, a boride reaction  $M5B3 \rightarrow 5M3B2$  may occur during heat treatment and subsequent aging. References 5: all Russian.  
[54-6508]

UDC 669.245

#### COMPOSITION OF SPHEROIDAL OBJECTS IN KhN77TYuR-VD ALLOY

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian  
No 10, Oct 85 pp 35-36

KOTKIS, M.A., NABUTOVSKIY, L.Sh., OSTROV, A.Ye. and ZILBERMAN, A.G.,  
Gorkiy Motor Vehicle Plant [Gaz], Plant imeni Lenin [Zil]

[Abstract] Scanning electron microscope studies of the fracture surfaces of impact specimens of alloy KhN77TYuR-VD ( $\leq 0.07\%$  C,  $\leq 0.6\%$  Si,  $\leq 0.4\%$  Mn, 19-22% Cr, 2.4-2.8% Ti, 0.6-1.0% Al,  $\leq 4.0\%$  Fe,  $\leq 0.01\%$  B,  $\leq 0.02\%$  Ce,  $\leq 0.015\%$  P,  $\leq 0.007\%$  Si) have revealed spheroidal objects, inclusions of true spherical or quasi-spherical form, on fracture surfaces of specimens with

low specific work of fracture. This article addresses the question of the nature of the objects. The heart of the spheroids consists of titanium, chromium iron, and nickel, the titanium possibly present as a carbide. The crust contains silicon, sulfur, and magnesium. The surface layer apparently consists of silicates and sulfides. The spheroids measured 20 to 200  $\mu\text{m}$  in diameter and decrease the specific work of fracture when present. The spheroidal objects may be present as a solid phase in a liquid melt, meaning that reactions may occur on their surface during cooling of the melt, which form nonmetallic inclusions containing silicon, sulfur, and magnesium. Photomicrographs are presented on the inside back cover of the journal. References 2: 1 Russian, 1 Western.  
[54-6508]

UDC 669.243+669.253:681.52

#### AUTOMATION OF HYDROMETALLURGICAL PRODUCTION OF NICKEL AND COBALT

Moscow TSVETNYYE METALLY in Russian No 10, Oct 85 pp 28-30

KAZANSKIY, L.A., KOTOV, V.A., LIFSHITS, G.A. and SHVARTSER, L.I.

[Abstract] Research and development work has resulted in the planning and construction of systems for purification of nickel anolyte at the Norilsk Mining and Metallurgical Combine and Severonikel Combine and a cobalt facility at Yuzhuralnikel Combine. These combines, plus the Ufaleyskiy Nickel Combine, are now utilizing 63 highly reliable continuous automatic production lines, combined into 11 production systems. Studies have shown that slight further improvements in hydrometallurgical processes of the refining of cobalt solutions and a transition from the final flame process for production of the metal to an electrolytic process using drum or disk continuous action electrolyzers will allow full automation of the production of cobalt, creating true automatic production facilities. A structural diagram is presented of the monitoring, control, and optimization of technological processes for production of heavy nonferrous metals utilizing small computers, minicomputers, and analog and digital control system regulators with built-in microcomputers.  
[59-6508]

UDC 658.26.003.1:669.295+52+669.72-52

#### CONSERVING POWER RESOURCES IN AUTOMATION OF TITANIUM AND MAGNESIUM METALLURGY TECHNOLOGICAL PROCESSES

Moscow TSVETNYYE METALLY in Russian No 10, Oct 85 pp 75-76

DEGTYARIK, N.V. and MALTSEV, N.Ye.

[Abstract] Several systems have been developed at the Zaporozhye affiliate of the Tsvetmetavtomatika All-Union Scientific Research and Design Institute,

including a system for centralized monitoring and control of the consumption of titanium tetrachloride to help stabilize the reduction of titanium; introduction of the Magniy automatic process control system, which records the performance of operations related to servicing of electrolyzers, monitors the yield of magnesium per current in each electrolyzer, calculates the running concentration of  $MgCl_2$  in the electrolyte melt, and performs centralized monitoring of the basic technological parameters of the electrolyzers; and development of an automatic electric power consumption control system to improve planning and norm-setting and to introduce scientifically valid norms for consumption of fuel and power.  
[59-6508]

UDC 620.172.251.1

#### TEMPERATURE DEPENDENCE AND STRESS-MODE DEPENDENCE OF RESISTANCE OF ALUMINUM ALLOYS TO FRACTURE

Kiev PROBLEMY PROCHNOSTI in Russian No 10, Oct 85 (manuscript received 12 Jun 85) pp 62-66

LEBEDEV, A.A., Institute of Strength Problems, UkSSR Academy of Sciences, Kiev

[Abstract] A study of the fracture kinetics in AMg6 and AMtsS aluminum alloys for cryogenic applications was made, the purpose being to determine the dependence of their resistance on the temperature and on the stress mode. Tests were performed on 1.93 mm and 2.83 mm thick cruciform sheet specimens in the "Lira" apparatus, this apparatus including a hydraulic loading device with four cylinders, a cooling system with a cryostat, a vacuum system, and a set of strain gauges. Heat flow to the specimens was inhibited by nitrogen shields; dissipation of heat from the specimens was facilitated by flexible coolant conduits. Intentional cracks in the center hub were induced, as stress concentrators, in the form of two diagonal saw cuts on diametrically opposite sides of the center hole (6 mm in diameter) which were then extended to a total length of 18 mm. With the thus stressed center part 80 mm in diameter, the specimens were loaded biaxially in the proportional mode with a controllable ratio of stresses in the two directions. Strain measurements, as well as still and high-speed photographs, revealed three successive stages of the deformation process, namely, elastic deformation without change in crack length followed by highly localized plastic deformation at the crack opening with accelerated widening and then by accelerated opening, prior to loss of stability and beginning of fracture. While the critical stress corresponding to the beginning of fracture was found to be almost independent of the temperature in the AMtsS alloy, it was found to be 10-15% higher at 77 K than at room temperature in the AMg6 alloy. References 4: 3 Russian, 1 Western (in Russian translation).  
[79-2415]



## RESISTANCE OF TITANIUM ALLOY TO DEFORMATION IN STRONG MAGNETIC FIELDS AT 293-4.2 K TEMPERATURES

Kiev PROBLEMY PROCHNOSTI in Russian No 10, Oct 85 (manuscript received 25 Feb 85) pp 115-122

STRIZHALO, V.A. and VOROBYEV, Ye.V., Institute of Strength Problems, UkSSR Academy of Sciences, Kiev

[Abstract] A study of the 3M  $\alpha$ -phase titanium alloy for cryogenic applications was made, the purpose being to determine the effect of strong magnetic fields on its resistance to deformation over the 293-4.2 K temperature range. Specimens of this alloy, 3 mm in diameter and 15 mm long, were annealed at 1123 K for 2 h before testing. Static tension tests were performed in a UMN-10 machine with and without a constant magnetic field of 6.4 MA/m intensity at 4.2 K. A superconducting magnet system was used for this purpose, with a stabilized IT-75M current source ensuring efficient and economical cooling. The solenoid, 145 mm in diameter and 180 mm long, had a maximum-current rating of 61.5 A and had been designed to produce a magnetic field uniform within 0.6% along a specimen. The results of this test, performed on 3-5 specimens and averaged accordingly, indicate that a constant magnetic field influences neither the ultimate strength nor the percent elongation and the percent reduction of this material but increases its 0.2% yield point, when applied in either direction along the axis of a cylindrical specimen. Dynamic tension tests were performed with a capacitor bank discharging through a special other solenoid and the latter producing magnetic field pulses with oscillations at a frequency of 8240 Hz, their intensity being raised up to 24.0 MA/m at 293 K, up to 32.0 MA/m at 77 K, and up to 14.4 MA/m at 4.2 K. The results of this test indicate a much more complex effect of a magnetic pulse field on the mechanical characteristics of  $\alpha$ -phase titanium alloy, namely, a step decrease of acting stress which becomes larger with increasing magnetic field intensity and with decreasing temperature followed, at 4.2 K only, by a gradual decrease of acting stress with attendant plastic deformation past the yield point. Interpretation of the results of both tests requires, because of the multiplicity of factors involved, a thorough analysis based on electromagnetic field theory and thermoelasticity theory. Calculations based on such an analysis reveal that thermal shock produced by eddy-current heating is the main factor determining the effect of magnetic field pulses on the resistance of a material with high electrical resistivity such as  $\alpha$ -phase titanium alloy to deformation at low temperatures. References 10: 8 Russian, 2 Western (both in Russian translation). [79-2415]

/13046

## NONMETALLIC MATERIALS

UDC 621.039.532.21

### CHANGE IN MACROSTRUCTURE AND POROSITY OF GRAPHITE UPON LONG-TERM IRRADIATION

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 21, No 9, Sep 85  
(manuscript received 13 Jan 84) pp 1490-1494

VIRGILYEV, Yu.S., BUTYRIN, G.M., KALYAGINA, I.P., NIKISHINA, L.M. and  
SHURSHAKOVA, T.N.

[Abstract] A study is made of changes in microstructure and macrostructure of highly irradiated reactor graphite specimens by mercury porometry, optical microscopy, and roentgenographic analysis. It is found that long-term neutron bombardment at 360 and 1220 K to a fluence of  $1 \cdot 10^{22}$  neutrons/cm<sup>2</sup> causes significant irreversible changes in graphite macrostructure, including a decrease in the volume of accessible pores with diameters of 7 nm to 50  $\mu$ m. Specific pore volume was decreased by a factor of about 2 and redistributed among the major pore groups. Density increased from 1.683 to 1.800 g/cm<sup>3</sup> as a result of growth of macroscopic pores combined with macroscopic pore closure, as a result of which the pores were not recorded by mercury porometry. References 8: 6 Russian, 2 Western.  
[48-6508]

UDC 541.7

### POLYMORPHISM OF BORON NITRIDE

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 21, No 9, Sep 85  
(manuscript received 10 Jan 84) pp 1495-1499

PALATNIK, L.S., GLADKIKH, L.I., KOLUPAYEVA, Z.I. and GABARAK, M.N.,  
Kharkov Polytechnical Institute imeni V.I. Lenin

[Abstract] A careful roentgenographic analysis of BN polycrystals with varying content of graphite-like boron nitride BN<sup>g</sup> (from 1 to 15%) is undertaken. Specimens of polycrystalline boron nitride were studied in their initial state, after sintering, and following heating. A layer about 0.5 mm thick was removed from the end surfaces of the specimens by diamond disk grinding under conditions not causing phase transformations. Specimens were studied on a diffractometer at 20 to 1700°C at 50-100° intervals with holding

at each temperature for 1 hour. Heating was performed in a vacuum of  $10^{-3}$  Pa. It was shown that in addition to phase polymorphism, a singular polymorphism also appeared resulting from changes in the contributions of various types of interatomic bonding under the influence of temperature and pressure. References 7: 6 Russian, 1 Western. [48-6508]

UDC 678.01

#### THERMAL DECOMPOSITION OF POLYMETHYLDIMETHYLSILAZANE

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 21, No 9, Sep 85  
(manuscript received 24 Jan 84) pp 1504-1507

MAZAYEV, V.A., TSAPUK, A.K. and YEFIMOVA, A.A.

[Abstract] A study is presented of thermal destruction of polymethyldimethylsilazane, used in ceramic technology as a bonding and saturating compound. Polymethyldimethylsilazane is obtained by coammonolysis of methyltrichlorosilane with dimethyldichlorosilane in a ratio of 3:1. Thermal decomposition of polymethyldimethylsilazane occurs primarily in the 200-800°C temperature interval. Crystallization of the inorganic residue begins at 1300°C with the formation of an  $\alpha$ - $\text{Si}_3\text{N}_4$  phase, while at 1800°C the inorganic residue consists primarily of  $\beta$ - $\text{SiC}$ , as well as the phases  $\alpha$ - $\text{Si}_3\text{N}_4$ ,  $\beta$ - $\text{Si}_3\text{N}_4$ , and a small quantity of  $\alpha$ - $\text{SiC}$ . References 9: 8 Russian, 1 Western. [48-6508]

UDC 666.241.24

#### SYNTHESIS OF ZINC-FREE RUBY GLASSES

Moscow STEKLO I KERAMIKA in Russian No 10, Oct 85 pp 6-8

SINEVICH, A.K., engineer, KARTASHOVA, G.I., engineer, and STAROBINETS, L.G., engineer, Neman Glass Plant; NFTTiP, BSSR Academy of Sciences

[Abstract] After unsuccessful attempts to found zinc-free glass with ruby coloration in an electric furnace, a further feasibility study was made using a laboratory furnace heated by natural gas. The purpose was to determine the effect of pigments and reducers added in various ratios on the color of sodium-calcium glass, specifically glass consisting of 75 mol.%  $\text{SiO}_2$  + 9.3 mol.%  $\text{CaO}$  + 15.7 mol.%  $\text{Na}_2\text{O}$ , as well as the effect of oxides of group-II metals on the color of the glass when equal amounts of pigment and reducer are added. Glass consisting of 75 mol.%  $\text{SiO}_2$  + 9.3 mol.%  $\text{ZnO}$  + 15.7 mol.%  $\text{Na}_2\text{O}$  served as reference for controlling the experiment and for color gaging. Four wt.%  $\text{CdS}$  and 0.35 wt.%  $\text{Se}$  were added as pigments;

potassium tartarate or charcoal was added as reducer. With 1%  $(\text{KCOH})_2(\text{COOH})_2$  or 0.15-0.2% charcoal as optimum amounts of reducer, slaking and satisfactory ruby coloration were obtained by decreasing the CdS content to 1-2 wt.% and increasing the Se content to 0.6-0.8 wt.% or by replacing CdS with 1.5-1.8 wt.%  $\text{CdCO}_3$  and increasing the Se content to 0.5-0.7 wt.% and also adding 0.17-0.2 wt.% S. With the same 9.3 mol.% of any of the other oxides ( $\text{MgO}$ ,  $\text{SrO}$ ,  $\text{BaO}$ ,  $\text{CdO}$ ) instead of  $\text{ZnO}$  or  $\text{CaO}$  and with more Se added or with the same amount of Se but with reducer added, measurements of the optical density over the 520-750  $\mu\text{m}$  range of wavelengths indicate the same optical selectivity within the range of ruby coloration, but with different transparency levels and the latter generally lowered by excess amounts of reducer. The results of this study were applied to production of tinted-glass window panes at the Neman Plant. References 2: 1 Russian, 1 East German. [63-2415]

UDC 666.11.01:620.193.4

#### EFFECT OF WATER CONTENT IN ACETONE ON CHEMICAL STABILITY OF KhS-3 GLASS

Moscow STEKLO I KERAMIKA in Russian No 10, Oct 85 pp 9-10

LISOV, V.N., candidate of technical sciences, ZVORYKINA, V.N., engineer, KOSTENKO, B.N., candidate of chemical sciences, SAGULENKO, A.M., engineer, and IVOLGIN, V.M., engineer, VNIIT, Sevastopol department

[Abstract] An experimental study of KhS-3 laboratory glass ( $69 \pm 2$  wt.%  $\text{SiO}_2$  +  $3.0 \pm 0.5$  wt.%  $\text{Al}_2\text{O}_3$  +  $2.0 \pm 0.5$  wt.%  $\text{B}_2\text{O}_3$  +  $7.0 \pm 0.5$  wt.%  $\text{CaO}$  +  $3.0 \pm 0.5$  wt.%  $\text{MgO}$  +  $14 \pm 1$  wt.%  $\text{Na}_2\text{O}$  +  $1.0 \pm 0.1$  wt.%  $\text{K}_2\text{O}$ ) in acetone with water was made, for the purpose of determining the effect of water on its chemical stability in this organic medium and thus supplement the studies made by academician I.V. Grebenshchikov concerning the stability of glasses in inorganic solutions. For establishment of a reference, acetone of extra-high purity was dried with zeolites and distilled in a quartz rectification column to a moisture content not exceeding  $2 \cdot 10^{-2}\%$ . This substance was diluted successively with 0.035-0.05-0.15-0.71-0.88 wt.%  $\text{H}_2\text{O}$ , the water content being monitored by gas chromatography. Specimens were poured into 1 mm wide hermetic annular cylindrical vessels of KhS-3 glass, after the latter had been cleaned with 10% aqueous  $\text{HCl}$  solution, rinsed with water bidistillate, and dried at  $200^\circ\text{C}$ . Two platinum electrodes had been fused into the glass for electrical conductance measurements, as proposed by A.G. Samartsov and V.S. Molchanov, with a Ye7-8 digital inductance-capacitance-resistance bridge inside a dry-air thermostat at  $30 \pm 0.1^\circ\text{C}$ . In addition, samples of acetone were periodically taken for determination of the  $\text{K}^+ + \text{Na}^+$  ion content by flame photometry with a FLAPHO-4 (GDR) instrument. The curves thus obtained, representing the electrical conductivity of acetone and the concentration of  $\text{K}^+ + \text{Na}^+$  ions in it as functions of time, reveal a saturation of both corresponding to a semilog law of corrosion film buildup on the glass surface. They also reveal that the electrical

conductivity of acetone increases faster as the water content increases, the initial electrical conductivity in the absence of a water-tight corrosion film being evidently proportional to the water content. The mechanism of the process in the initial stage, characterized by a fast dissolution of glass, is a reaction of the first kind with water. This reaction lasts only a few minutes in highly diluted acetone or other substance, but spreads over many days and even a year in highly concentrated or almost pure acetone. For engineering design of acetone storage vessels the semiempirical relation  $\Delta\sigma = 3.3 \cdot 10^{-8} \frac{CS}{V} \log \tau$  is proposed. ( $\Delta\sigma$ , S/m - increment of electrical conductivity of acetone, C, wt.% - water content in acetone, S, m<sup>2</sup> - area of glass surface, V, m<sup>3</sup> - volume of acetone,  $\tau$ , days - duration of acetone-glass contact.) References 2: both Russian. [63-2415]

UDC 666.293

#### REGULATING THERMOMECHANICAL PROPERTIES OF ENAMEL COATINGS

Moscow STEKLO I KERAMIKA in Russian No 10, Oct 85 pp 13-14

ZHDANOVA, T.D., engineer, SMISHCHENKO, O.P., engineer, MORGUN, I.V., engineer, BORUSHKO, O.I., engineer, and KHODAKOVSKAYA, R.Ya., doctor of technical sciences, Moscow Chemical Technology Institute imeni D.I. Mendeleev; NII emalkhimmash

[Abstract] A method of regulating the porosity of enamel prime coatings and thus minimizing their modulus of elasticity has been developed which involves adding various kinds and amounts of gasifiers rather than metal oxides which degrade the manufacturability of such coatings. The most effective gasifiers, producing a uniform fine porous structure, are fine BN and TiH<sub>2</sub> crystals. In an experimental study for evaluation purposes, these substances were added in amounts of 1-10 wt.% along with conventional comminuting agents such as clay, quartz sand, and borax to enamel coatings during their deposition on 08sp low-carbon steel by the usual process. The manufacturability of the resulting enamel coatings was gaged on the basis of appearance, critical wetting angle measured under a high-temperature microscope, and annealing range. The area under bubbles was measured on photographs of microsections by the method of secants. Phase transformations in the enamel were monitored by differential thermal analysis on the basis of Paulik-Erdelyi derivatograms. Mechanical tests and petrographic analysis have revealed that the optimum amount of BN or TiH<sub>2</sub> added to 3132 enamel lies within the 1-3 wt.% range, producing a uniform distribution of pores up to 20  $\mu$ m in size, BN being a more powerful gasifier than TiH<sub>2</sub>. Both require that the furnace temperature for optimum annealing be 50-70°C lower than for conventional annealing of enamel without gasifier. The exothermic effect of BN and TiH<sub>2</sub> oxidation plays a supportive role here, inasmuch as the attendant spontaneous heating of enamel decreases the critical wetting angle and lowers the annealing temperature. Inasmuch as pores absorb some of the energy

imparted to a coating under an impact load, moreover, a smaller surface area is fractured, and the impact strength of a coating is increased even much more than its modulus of elasticity is decreased so that the quality of the coating is improved in two ways. References 6: all Russian.  
[63-2415]

UDC 666.593.2:668.31

#### GENERAL-PURPOSE ADHESIVE FORMULATION FOR ELECTRIC-GRADE PORCELAIN PRODUCTS

Moscow STEKLO I KERAMIKA in Russian No 10, Oct 85 pp 18-19

KHRISTOFOROV, K.K., candidate of chemical sciences, VINOGRADOVA, T.K., engineer, BELENKAYA, Ye.S., engineer, and OMELCHENKO, Yu.A., candidate of chemical sciences, Scientific Research Institute of the Elektrokeramika Production Association

[Abstract] A general-purpose adhesive formulation for joining parts made of electric-grade porcelain has been developed which combines maximum water tightness with satisfactory mechanical and electrical strength. This was found to be achievable by controlled addition of AF-2 low-temperature aminophenolic resin to a mixture containing 100 parts of ED-20 epoxy resin + 15 parts of triethanolamine + 50 parts of porcelain powder. The gel-formation rate depends largely on the AF-2 content, 5 parts of AF-2 being the optimum amount to be added. After heat treatment at 120°C for 5 h, the adhesive will gelate in approximately 10 h at room temperature. With less than 5 parts of AF-2 the necessary degree of water tightness will not be reached. With more than 5 parts of AF-2 the exothermic gel-formation process will cause foaming and an attendant dropping of the water tightness below its initial degree and also a weakening of adhesion to porcelain. The formulation has been established on the basis of mechanical tests for loss of strength after 30 days of soaking in water, for length of the gel-formation process, and for tear strength as functions of the AF-2 content. The mechanical characteristics of the adhesive were found to worsen somewhat after thermal shock or soaking in an environmental chamber, evidently owing to plastification of the adhesive seam with attendant lowering of its cohesion strength. The electrical strength of the adhesive was measured between 2.5 mm thick porcelain tubes and between 2.5-4.5 mm thick porcelain disks. Its electrical volume resistivity was found to drop not more than 7% and to remain higher than that of porcelain even after thermal shock or soaking in an environmental chamber. References 5: all Russian.  
[63-2415]

## THIN-GAGE MULTILAYER WINDSHIELD GLASSES FOR VAZ-2108 AUTOMOBILES

Moscow STEKLO I KERAMIKA in Russian No 10, Oct 85 p 25

MAKSIMOV, V.V., engineer, KOROBKIN, N.P., engineer, SHUTOV, A.I., engineer, KHRIPUNOVA, I.I., engineer, LEGOSHIN, G.M., candidate of technical sciences, and CHUGUNOV, A.M., engineer, Bor Glass Plant imeni M. Gorkiy; VNII tekhnosteklo

[Abstract] A technology has been developed for experimental and then industrial production of 5-5.5 mm thick triplex curved glass panes to be used as windshields in the VAZ-2108 small automobiles. The windshield of this thickness and having an area of  $0.98 \text{ m}^2$  is to replace the 6-6.8 mm thick windshield with an area of only  $0.77 \text{ m}^2$  used on previous VAZ models. Thermally polished glass of 2.25 mm thickness is used as the base material, two layers being joined together with a 0.76 mm thick film of Butvel adhesive (polyvinyl butyraldehyde). Ingots of the triplex pairs are mollied in a 2-channel furnace in nondissemblable frames made of Kh18N10T heat-resistant steel, this process being optimized by corrective zonal temperature control. It is followed by washing and drying, to a moisture content in the adhesive not exceeding 0.38-0.52%, and subsequent heating in an electric tunnel furnace at 82-85°C. Final calendering is done by conventional methods, after prepressing in an air-filled autoclave. The product, after visual inspection and meeting the GOST 5727-83 All-Union State Standard, as well as the YeEK OON No 43 specifications, is wrapped and packed in special containers for shipment to the automobile assembly plant. Commercial production of this windshield is to begin soon at the Bor Glass Plant. [63-2415]

/13046

## PREPARATION

### EXPLOSION WELDING DEMONSTRATED

Minsk SOVETSKAYA BELORUSSIYA in Russian 31 Aug 85 p 2

[Article by V. Bibikov: "Reining in the Explosion"]

[Text] In our consciousness an explosion is associated first and foremost with destruction. In the Belorussian Republic NPO [scientific production association] for Powder Metallurgy it is made to perform creative work.

One explosion rumbled, a second, a third.... Just like on an artillery range.

N. V. Naumovich, department head of the NPO for Powder Metallurgy proposed that we see everything with our own eyes. We drop in at a massive reinforced concrete bunker, and each of us takes an individual protection key from a special panel (while it is not in place, an explosion is impossible). Not far away, on a level sandy platform, workers place a metal sheet, and fasten another from above at a small distance. This "sandwich" is completed with a layer of explosive resembling yellow flour.

Now only the master powderman remains on the platform. Having set the detonator, he hides in the shelter. An Explosion! We hurry to see what happened. And we see that the two metal plates are permanently connected together. Nikolay Valentinovich explains:

We have seen explosion welding. It permits joining metals which are either difficult or impossible to join using ordinary methods. For example, steel with aluminum or molybdenum, with the joint being strong, plastic, for the weld occurs over the entire contact surface. It is thus possible to manufacture materials which have the properties of several metals, let us say the strength of steel with the electroconductivity of copper. These can be plates, pipes or shaped blanks.

Reining in the explosion was first approached in our republic in the 1960's by scientists of the Belorussian Polytechnical Institute. At first, they proceeded by trial and error. But it soon became clear they would not get far that way. Imagine how many experiments would have to be set up to weld, for example, a pack of 20 sheets, and of varying thickness, "by touch."



In a word, it was necessary to learn to control the explosion. They showed me a film taken from the above-mentioned bunker by a special high-speed camera at 3,000 frames per second. It turns out that ammonite does not explode all at once, but gradually, forming something like a traveling wave. A second piece of equipment permitted it to be established that the pressure upon explosion reaches several tens of thousands of atmospheres, and the velocity of the upper plate (the one being hurled) reaches up to 1,000 meters per second. As a result, the blanks are joined so compactly that the forces of interatomic attraction come into play. A similar effect may be achieved in a rolling mill in which the sheets of metal move within the rollers at a speed of 3 kilometers per second. But it is apparently possible to create these conditions only in theory.

Today it is possible to join 100 plates of metal at once based on the theoretical developments of the Belorussian scientists. This is not a record for the sake of a record. The explosion welder is working in production more and more actively. As an example, associates of the Belorussian NPO for Powder Metallurgy joined such "capricious" and rare metals as hafnium, niobium and palladium to a copper base on an order from industry. Here the explosion replaced silver soldering, resulting in an annual savings of 300,000 rubles.

In another instance, current feeds for electrolyzers, consisting of copper and stainless steel and copper and titanium, were produced by explosion. Formerly they were riveted together, but did not last long. The explosion prolonged the life of the current feeds by a factor of several times and increased the efficiency of the electrolyzers. Now the parts made in the new fashion are used in a number of enterprises in non-ferrous metallurgy, saving more than 3 million rubles.

The bimetals produced at the NPO for Powder Metallurgy also permit us to conserve a significant amount of alloyed metal in the manufacture of metal-cutting and stamping tools. They are now manufactured solely from scarce alloy steel. However, only a small part of them operates with an increased load. The remainder may be made from ordinary metal. It is the same explosion, as you may have already guessed, which will join the two parts. The innovation has already been successfully tested at several Minsk plants, and it may yield a savings of from 40 percent to 80 percent in alloyed steel when manufacturing tools.

It only remains to be said that the developments of the Belorussian NPO for Powder Metallurgy in the area of explosion welding are of world class, protected by more than 100 patents in the USSR, and have been commemorated more than once with medals at the USSR VDNKh [Exhibition of the Achievements of the National Economy]. On request from a number of ministries and departments of Belorussia and the country as a whole, bimetals in dozens of descriptions have been produced at the Association using explosion technology, which brought about a savings of more than 12 million rubles for the national economy just for the Eleventh Five-Year Plan.

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CSO: 1842/55

## ELECTROSLAG CASTING PROCESS USED TO REDUCE WASTE, IMPROVE QUALITY OF METAL

Moscow PRAVDA in Russian 10 Oct 85 p 2

[Article by O. Gusev, PRAVDA correspondent: "Restored by Fire - Economy as a Means for Growth"; passages enclosed in slantlines printed in boldface]

[Text] /Kalinovka, near Kiev, a built-up area recently considered to be exclusively rural, has become a place frequently visited by metallurgical plant personnel and scientists from a number of the republic's oblasts. Here the Ukrainian Gosnab, in collaboration with the Ukrainian SSR Academy of Sciences, has organized the first regional center in the republic for preparing metal products for their more efficient use./

It goes without saying that the task is of the utmost importance: the highly convenient metal pattern layout method proposed in Kalinovka should bring about a considerable reduction in metal waste, making it possible in the cutting operation to utilize the scraps to a greater extent. An important detail here is the fact that each person arriving here will learn the best methods of handling rolled metal, piping, and shaped sheet steel, with the intent of reducing waste to a minimum.

Specialists of the Electric Welding Institute imeni Ye.O. Paton, Ukrainian SSR Academy of Sciences, have become the unique teachers of the center. They show how to save metal and how to reuse the output of the open-hearth furnaces and rolling mills. The republic Gosnab and the institute are helping to set up here a production unit for reprocessing steel waste, firing scrap to produce superior quality steel.

This is an example of how closely the interests of researchers developing new technologies for the reprocessing of metal coincide with the concerns of the specialists responsible for providing them to industry and for effecting close monitoring to insure highest possible efficiency in the consumption of the "bread of industry." One can also see a clear embodiment of the need for closer integration of the efforts of researchers and production personnel on the way to the accelerated development of ferrous metallurgy. This is an especially useful contribution to the

valuable storehouse of knowledge acquired by such research. The Electric Welding Institute, as we know, is working in extremely important areas of scientific and technical progress which now are becoming an indispensable condition for the intensification of the economy. They lead to the more efficient use of resources and of all elements that comprise social production.

Engineering centers are assuming a central position in this activity. They are problem-oriented, integrated, interbranch scientific and technical units concerned with the realization and introduction into practice of the results of scientific research and also with training of personnel for mastering the new technologies. At the same time, the ties with industry which are forming enable the researchers to acquire a more profound knowledge of production requirements and to respond effectively to new developments.

"What is the advantage of your technical discovery?" is a question traditionally heard in the "five-minute meetings" held in the institutes departments and within the management. People have become accustomed to hearing this question; they expect to begin their regular workday with a detailed reply. This is natural, since in such meetings each person more or less sets for himself a new horizon, the reference point for which is an attempt, as required by the resolutions of the April (1985) Plenum of the CPSU Central Committee, to shift more rapidly to fundamentally new technologies, to the latest generations of equipment.

One of the "fruits" of the institute's work is an enormous ingot, in comparison with which a man appears to be as small as an insect. It was produced for the first time in the world by means of unusually powerful fire processing. This is the term used for brevity by its inventors -- institute specialists -- for the electroslag technology of metal quality improvement developed in the USSR.

In becoming familiar with it during tours of the institute, metallurgists from Moscow and Sverdlovsk, Leningrad and Chelyabinsk, specialists from scientific research institutes and central plant laboratories are interested not so much in individual details of the new processes as they are in the method of their organization. To render them even more rapid assistance, the institute has initiated the making of films concerning the most recent attainments of a number of its departments.

The Bolshevik production association in Kiev remade a technical training film depicting plant personnel who were the first to apply the then new electroslag casting technology developed by the scientists. Why was the film a remake? Because the version made there several weeks previously was obsolescent. The tempo associated with producing electroslag castings was so accelerated that yesterday's object recorded in the big plan was no longer suitable for inclusion with the "main heroes." Life outstripped art, and operators had no choice but to follow the installers.

The film "Electroslag Casting in Kiev Enterprises," produced by Ukrtelefilm with the scenario written by the scientists, was not only viewed with

interest in such large enterprises of the republic's capital as the Bolshevik, Arsenal, Leninskaya Kuznitsa and imeni Lapse plants, but additionally was immediately designated as a mandatory graphic aid.

The plants in short order commenced disseminating information on the new developments not only via lectures, but also by means of the moving picture screen. There was indeed a story to tell; electroslag technologies, as the practical personnel saw, are bringing about highly visible changes in traditional metal working processes.

"Enthusiasts of their wide application are becoming even more convinced," related Doctor of Technical Sciences G. Boyko. "Their numbers are growing with every month. Thus, in the Kherson Combine Plant production association, construction was started on an electroslag casting section which is a model for the branch. It went into operation at the end of last year. Although general assimilation of this kind of technology is only starting here, the main gain is obvious: The problem of deliveries of high alloy tool steels which troubles many enterprises has been solved in the association. They make them on their own equipment by remelting unserviceable dies. The metal melted in this manner can be used to produce as many items as are required for everyday needs."

In the beginning of this year, a group of association specialists attended a practical course at the Plant imeni Lapse in Kiev dealing with the new metal processing technology; they are presently communicating their experience to colleagues. On the initiative of the scientific and technical progress assistance council, which has been operating for several years in the Kiev party gorkom, introduction of electroslag reprocessing is the object of close attention.

I was informed by the management of the Bolshevik association that the electroslag casting equipment operating at the head plant paid for itself in only 1.5 years, and in the forging shops and foundries there is less noise and more cleanliness than, say, 3 to 5 years ago.

"There is a reason," commented Academician B. Medovar of the Ukrainian SSR Academy of Sciences, "why the Bolshevik is frequently visited by representatives of similar enterprises. Today, the most critical shut-off power fittings for nuclear and thermal electric power plants are being manufactured in our country by the electroslag casting method."

An engineering center recently organized in the Electric Welding Institute has helped the Kiev personnel accelerate production rates. Its major advantage is operational efficiency; scientists set up direct contacts with industry without delay. A recent example is the case of the USSR Mingazprom (Ministry of the Gas Industry) urgent requirement for "T-joints," which are complex metal devices used to draw off gas from main lines.

Center specialists delivered to one of the ministry's plants -- the Fastov plant in Kiev oblast -- equipment developed in the institute and instructed the local specialists in its use. Now the "T-joints" are operating full-force.

The engineering centers of the institute -- there already are six of them -- are helping to rapidly pass on to industry concepts and results of scientific developments. Introduction time has been shortened by almost two years.

The new technology, which successfully complements traditional methods of producing intermediate products, assures the highest quality of machine building products and affords considerable savings. Electroslag steel, which became a reality as a result of the efforts of the Kiev researchers, is now being used ever more often in the most diverse branches of the national economy.

13005/13046  
CSO: 1842/73

## MODERNIZATION ACTIVITIES AT THE MAGNITOGORSK METALLURGICAL PLANT

Moscow SOVETSKAYA ROSSIYA in Russian 12 Nov 85 p 1

[Article by G. Alekseyev and V. Denisov, SOVETSKAYA ROSSIYA correspondents, Magnitogorsk-Sverdlovsk under the rubric "Behind the Lines of the Draft Basic Directions": "The Second Birth of the Magnitogorsk Metallurgical Combine"]

[Text] "To Reconstruct the First Phase of the Steel Smelting Unit of the Magnitogorsk Metallurgical Combine"

The giant of heavy industry - the Magnitogorsk Metallurgical Combine - is standing at the threshold of a second birth. Major reconstruction is on the way: about half the fixed capital has been in operation more than 30 years. Although the Magnitka [Magnitogorsk Metallurgical Combine] produces almost 16 million tons of steel a year, every fourth ton is discarded or remelted. The obsolete method of melting in open-hearth furnaces and casting into ingot molds is having its effect.

Today, the legendary Magnitka is finding its "second wind." The collective of the enterprise, with the assistance of scientists, has developed a project and initiated construction of an oxygen-converter shop which in many respects is unique in its production technology.

"The first phase of the shop, relates leading specialist of Magnitogorsk institute Gipromez [State All-Union Institute for the Designing of Metallurgical Plants] chief project engineer A. Novlyanskiy, "is planned to be set into operation in 1989. This task includes constructing two converters each possessing a capacity of 370 tons and four continuous casting machines. The second phase will become operational three years later. Complete development calls for production of 9 million tons of steel a year."

As the first phase is started up, an open-hearth shop and a slabbing mill - a machine which rolls castings - will be phased out in stages. Sometime in the future, construction of a second oxygen-converter shop will be started, after which the furnaces of the remaining open-hearth shops and the blooming mills will cease operating. It is planned to provide the Magnitogorsk converters with a more intensive oxygen blast and argon blow, which will

bring about an appreciable reduction in ferroalloy consumption. It is also planned to purify metals in a vacuum. The new shop design incorporates another feature associated with the intensity of the technological process: the charge is planned to contain up to 45 percent metal scrap - 1.5 times more than at present. The steel smelters will require less molten pig iron.

At one time, the first high-capacity continuous casting slabbing mills were manufactured at Uralmash [Ural Heavy Machinery Plant]. Now, development of the design of the machines for the Magnitka is nearing completing in the Uralmash institute of NIIt'yazhmash. The use of continuous casting increases the yield of suitable product; from every million tons of molten steel, the country will obtain approximately 200,000 tons more rolled metal. P. Soloveychik, machinery project chief designer for the Magnitogorsk Combine, said "The new machines, the first of their kind in world practice, will have the capability of casting steel in two or four channels. In addition, the casting rate will be independent for each channel. Without going into technical details, I will explain merely that the new machines will greatly facilitate the production process and bring about a considerable improvement in the quality of the castings. The machines are distinguished by reduced metal input, and the shop in which they will be installed need not be as large. Steel smelting and continuous casting are combined with a high level of automation of technological processes using computers."

The Uralmash personnel are relying on the interest and support for the project on the part of collectives of research institutes, design offices, and enterprises of related sectors. The most recent automation and control devices, electrical equipment, high-grade small bearings, and refractories of especially high resistance are required. Moreover, all this should meet the scientific and technical requirements of the next decade.

The collectives of two giants - one metallurgical and the other machine-building - have joined forces and decided to bring about a substantial improvement in production intensification. They are relying on the broad introduction of the achievements of science and technology.

13005/13046  
CSO: 1842/73

## NEW METAL REPROCESSING FACILITY NEARING COMPLETION IN SOVIET FAR EAST

Moscow IZVESTIYA in Russian 15 Nov 85 p 1

[Article by G. Zazvonov, Komsomolsk-on-Amur: "In Anticipation of the Command 'Start!'" ; passages enclosed in slantlines printed in boldface]

[Text] /Construction of the Stal complex in the Far East Metallurgical Processing Plant is nearing completion.

In the same way as in similar enterprises located in Belorussia and Moldavia, there will be no traditional metallurgical cycle here. There will be no open-hearth or blast furnaces enveloped in clouds of red dust and gas. Carefully prepared metal scrap will be fed into electric steel-smelting furnaces./

Heat, water, electric power, oxygen. Today, these words are constantly repeated by all the members of the All-Union Komsomol Shock-Work Construction Site. Without these ingredients, the electric steel-smelting shop could not be set into operation. Installers working under Fedor Sharlaimov have undertaken to "tie in" to the route of the closed water circulation system and to supply water to the shop. They managed to assemble 12 high-tonnage furnace housing panels one month ahead of schedule.

Start-up and adjustment operations have been initiated on the first electric furnace and a six-channel continuous casting machine. Specialists of Vitaliy Dudyrev's brigade from the Dalektromontazh trust are completing operations on the main control panel for the steel foundry production unit. Fifty contract brigade men installed 150 kilometers of cable in the shop in brief time periods.

"The Far East plant is badly needed in the area," said USSR Ferrous Metallurgy Deputy Minister A. Kugushin. "It will expand considerably the metallurgical base in the eastern part of the country. Its two powerful electric furnaces will provide 522,000 tons of steel a year. The finished product - channel bars, angles, and square, round, and hexagonal high-strength steel - is very necessary for the new projects of the territorial production complexes and industrial centers which will be established in the zones of the BAM [Baykal-Amur Trunk Line] and the Amur-Yakutsk Trunk Line."



Every day in the construction site headquarters, large machine units and individual objects are shaded on the chart to show that they are ready for operation. Every day arrows of various colors on the start-up schedule approach the red flag that represents the first smelting operation. Dozens of brigades are earning the right to participate in this ceremony. A short time will pass, and metallic raw material will be loaded into the fire-breathing furnace. Hundreds of mechanisms, motors, and devices vital to its functioning will come to life, and there will resound the long-awaited command "Start!"

13005/13046  
CSO: 1842/73

UDC 621.762.4.04:778.4

# STUDY OF KINETICS OF COMPACTING OF METAL POWDERS DURING PRESSING

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA  
in Russian No 9, Sep 85 (manuscript received 19 Dec 84) pp 97-100

BAKHTIN, V.G., POLUKHIN, P.I. and KUDRIN, A.B., Moscow Steel and Alloys  
Institute

[Abstract] Determination of deformations in early stages of deformation were performed by two-exposure holographic interferometry. The relative density increment of a powder brickette of height  $h$  was related to the movement of the die between exposures by the equation  $\Delta\rho/\rho = \delta h / (h - \delta h)$ , where  $\Delta\rho/\rho$  is the increment of density, and  $\delta h$  is the change in die height between exposures. It is shown that the method is suitable for studies of the kinetics of compacting of powder materials. The change in primary mechanism of compacting of the powder material during the process of pressing leads to a change in the distribution of deformations through the volume of the brickette being pressed. References 5: all Russian.  
[50-6508]

UDC 621.318.12

# INFLUENCE OF BINDER COMPOSITION ON PRESSABILITY OF FERRITE PRESSING POWDERS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA  
in Russian No 9, Sep 85 (manuscript received 14 Jan 85) pp 162-163

MAKAROV, B.V., ANDREYEV, V.G. and LETYUK, L.M., Moscow Steel and Alloys  
Institute

[Abstract] A study is made of the problem of increasing the pressability of pressing powders by introducing electrolytes forming a dual electric layer on the surfaces of the particles. Experiments were performed using powders of the magnetically soft ferrite type 2000NMI with a mean particle diameter of  $1.0 \mu\text{m}$ . Binders containing stronger electrolytes or electrolytes with multivalent cations were found to form double electric layers with intense fields on the surfaces of the particles, decreasing the friction between them, which was confirmed by the achievement of good pressability when polyelectrolytes were used as binders. References 2: both Russian.  
[50-6508]

## STRUCTURE AND WEAR RESISTANCE OF POROUS IRON-GRAPHITE MATERIALS AFTER ELECTROMECHANICAL TREATMENT

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian  
No 10, Oct 85 pp 11-12

ASKINAZI, B.M., NAUMCHEV, S.B. and SHEVLYAKOV, V.P., Ulyanovsk Agricultural Institute

[Abstract] Studies were performed on the influence of electromechanical treatment conditions on the properties of the surface layer of sintered iron-graphite materials types ZHGr2D and ZHGr1.2D2.8. Electromechanical treatment resulted in the formation of a white slightly etched material consisting of martensite and residual austenite. X-ray structural studies showed that with increasing electric current the content of carbon in the martensite increased along with martensite block size, the quantity of residual austenite and surface layer hardenss. The use of electromechanical treatment allows significant increases in the durability of friction units with sintered iron-graphite bushings due to structural changes and increases in the density of the surface layer. References 5: all Russian.  
[54-6508]

UDC 621.762

## IMPROVEMENT OF MECHANICAL PROPERTIES OF POWDERED STEEL BY HEAT TREATMENT

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian  
No 10, Oct 85 pp 12-14

KARTASHOVA, L.I., TSYRKIN, A.T., TREGUBOV, V.A., PLAKHOTNIK, V.Yu. and ALESHINA, L.I.

[Abstract] A study is made of the influence of annealing temperature on the mechanical properties and grain size of steel containing 0.08-0.12% C, with a 3% porosity, obtained from PZH4M2 iron powder by cold pressing, heating in a protective medium to 1100°C, holding 15 minutes, and dynamic hot pressing of 11 x 11 x 65 mm blanks. Increasing the annealing temperature was found to facilitate an increase in strength and ductility characteristics, the best combination being achieved at 1000-1100°C. The grain in powder steels increases significantly more slowly than in cast or forged steels, remaining small even after annealing at 1100°C. However, holding at 1100°C yields firmer contacts between particles. References 4: 3 Russian, 1 Western.  
[54-6508]

PROCESSING COPPER-CONTAINING ZINC PRODUCTION INTERMEDIATES AT THE  
UKRAINIAN LEAD AND ZINC COMBINE

Moscow TSVETNYYE METALLY in Russian No 10, Oct 85 pp 44-47

BUDON, G.D., KULENOV, A.S., NEVEROV, L.P. and KOROTIN, A.D., Deceased

[Abstract] Studies performed at the authors' facility have resulted in the development and introduction of a new technology for processing of copper-containing zinc production intermediates, yielding cuprous oxide by the cementation method. The initial product used in the production of the oxide is copper-chloride cake obtained in purification of zinc solutions to remove the chloride ion. The cake was leached in 60 m<sup>3</sup> agitators with oxidizers present to accelerate dissolution of the cake. Leaching was performed at an initial acidity of 55-70 g/dm<sup>3</sup> at 70-80°C for 18-20 hours, to a residual acidity of 1.5-10 g/dm<sup>3</sup>. Leaching was followed by hydrolytic purification of the slurry to remove iron, arsenic, and antimony. Oxidation was then performed in the presence of copper ions. After hydrolytic purification, the slurry was filtered, copper extraction during leaching and hydrolytic purification reached 86-90%. The new process increases the completeness of utilization of raw materials and the effectiveness of production by increasing the extraction of zinc, cadmium, lead, and copper from the intermediate products.

[59-6508]

/13046

## TREATMENTS

UDC 546.28:539.23

### POLYCRYSTALLINE SILICON LAYERS

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 21, No 9, Sep 85  
(manuscript received 3 Jan 84) pp 1445-1448

CHASHCHINOV, Yu.M., BOGOMAZ, A.V., FALKEVICH, E.S. and SHVARTSMAN, L.Ya.,  
Leningrad Mining Institute; Zaporzhye Titanium-Magnesium Combine

[Abstract] Results are presented from a study of the surface morphology and structure and texture of polycrystalline layers of silicon performed using electron-optical, gonimetric, roentgenographic, and stereometric methods of investigation. Layers of polycrystalline silicon 90-570  $\mu\text{m}$  thick obtained in the process of the hydrogen reduction of tetrachlorosilane and trichlorosilane were studied. Layers were precipitated at 1300-1550 K, chlorosilane/hydrogen molar ratio 1:5-1:20, onto silicon plates 30 and 60 mm in diameter with 1.5-3.5  $\mu\text{m}$  silicon dioxide coatings. The growth form and structure of the polycrystalline silicon layers revealed the presence of characteristic growth macrocenters with twin (220) texture. The dominant silicon growth form was  $\{311\}$ . The grain boundaries form a linearly oriented system of surfaces. The structure of the polycrystalline silicon is nonuniform in thickness, the specific surface of grain boundaries decreasing linearly with increasing distance from the substrate.

References 5: all Russian.

[48-6508]

UDC 539.26

### INFLUENCE OF MICROSCOPIC DEFECTS ON ABSORPTION OF X-RAYS IN SILICON WITH LAUE DIFFRACTION

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 21, No 9, Sep 85  
(manuscript received 9 Jan 83) pp 1449-1452

BUBLIK, V.T., LITVINOV, Yu.M., POSTOLOV, V.G., OVCHARENKO, V.M. and  
TUZLUKOV, A.A., Moscow Steel and Alloys Institute

[Abstract] Microscopic defects were studied in dislocation-free silicon crystals, grown by the Chokhralskiy method, using metallographic analysis,

determination of integral anomalous x-ray transmission characteristics, and measurement of lattice parameter by the Bond method. The study of the influence of swirl defects on the interference absorption coefficient  $\mu_i$  indicated that micro defects form local elastically stressed areas with modified x-ray diffraction conditions. Calculations show that the changes in diffraction characteristics caused by microscopic defects average 0.1-0.3". Since microdefects create small elastic stress fields, higher orders of reflection are preferable for their investigation. Microdefects producing a swirl picture are found to be interstitial defects formed by nonequilibrium interstitial silicon atoms. References 10: 5 Russian, 5 Western.  
[48-6508]

UDC 546.32'885

#### SYNTHESIS AND RECRYSTALLIZATION OF LITHIUM TANTALATE SINGLE CRYSTALS UNDER HYDROTHERMAL CONDITIONS

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 21, No 9, Sep 85  
(manuscript received 24 Feb 84) pp 1564-1566

POPOLITOV, V.I., Crystallography Institute imeni A.V. Shubnikov, USSR Academy of Sciences

[Abstract] Results are presented from the synthesis and recrystallization of lithium tantalate single crystals by a hydrothermal method. The single crystals were obtained from  $Ta_2O_5$  and lithium tantalate, the crystallization medium being aqueous solutions of caustic potash and lithium, potassium bifluoride and hydrogen peroxide, and of lithium carbonate. The optimal solvent for recrystallization of lithium tantalate and its growth is found to be a mixed aqueous solution of  $Li_2CO_3$  and  $H_2O_2$ . References 4: all Russian.  
[48-6508]

UDC 621.771.01

#### STUDY OF PARAMETERS OF PRESSING OF PIPE WITH SPIRAL REINFORCEMENT

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 9, Sep 85 (manuscript received 11 Jul 84) pp 100-103

KOLIKOV, A.P., NIKISHOV, O.A., BONDAREV, M.A., FILIMONOV, G.V., GOLOVACHUK, A.A. and PARFENOV, A.B., Moscow Steel and Alloys Institute

[Abstract] A study is made of the basic features of the method of calculating the parameters of billets with spiral reinforcing fibers which permit the production of pipe with the necessary filling factor and uniform distribution

of fibers in the matrix material. One of the most important factors influencing uniformity of fiber distribution in pressed pipe is the method of the laying of the reinforcing fibers and their placement in the volume of the billet. The process of the flowing of the fibers as the pipe billet is reduced in cross-section is discussed and diagramed. The geometric parameters of a billet to be used for pressing of pipe with spiral reinforcement are determined. Equations are derived which allow production of spirally reinforced pipe of high quality without corrugation of the fibers. Ways are demonstrated for increasing the pipe filling factor while fulfilling the condition of fiber flow through the equipment without corrugation. References 3: all Russian.  
[50-6508]

UDC 621.771.2

#### CHANGE IN TEMPERATURE IN JOINT ZONE OF CLAD STRIP WHEN ROLLED IN A VACUUM

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 9, Sep 85 (manuscript received 15 Jan 85) pp 161-162

ROSHCHUPKIN, V.G., GORBATYUK, S.M. and ROSHCHUPKINA, T.S., Moscow Steel and Alloys Institute

[Abstract] In order to render more precise the temperature in the zone of welding of bimetals with thin clad layers obtained by cold rolling in a vacuum, direct measurement of the temperature at the interface between layers of chromel-alumel thermocouple wire 0.05 mm thick was performed. There were no oxide films on the compounds, increasing heat transfer to the rolls and decreasing the temperature in the area of welding of the bimetal in comparison to rolling in air. Changes of temperature in the area where the bimetals were welded in the process of rolling under mild vacuum and subsequent cooling of the rolled product were determined. References 1: Russian.  
[50-6508]

UDC 621.787.4+621.762

#### STRENGTHENING POROUS STEEL AND TITANIUM BY COLD PLASTIC DEFORMATION

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 10, Oct 85 pp 14-16

LAPTEV, A.M. and OBODOVSKIY, Ye.S., Kramatorsk Industrial Institute; Special Design Bureau of Hydraulic Impulse Techniques, Siberian Department, USSR Academy of Sciences

[Abstract] A study was made of the mechanism of hardening of sintered metals upon plastic deformation. The basis of the analysis was the theory of

plasticity of porous bodies. Equations are derived for the hardening of the metal base of a porous body upon cold plastic deformation. The curve of hardening of the metal base of a porous body usually does not coincide with the hardening curve of cast metal of similar chemical composition and depends little on the initial relative porosity. References 4: 1 Russian, 3 Western. .  
[54-6508]

UDC 621.771.2:681.52

#### PROCESS CONTROL SYSTEMS FOR NEW REVERSING HOT STRIP ROLLING MILLS

Moscow TSVETNYYE METALLY in Russian No 10, Oct 85 pp 93-95

ROZOVSKIY, Yu.L.

[Abstract] Nonferrous metal processing plants are now receiving new duo 850 hot strip rolling mills equipped with automated process control systems developed by Soyuztsvetmetavtomatika Scientific-Production Union with the cooperation of the Giprotsvetmetobrabotka Institute and the Tyazhpromelektroproyekt Scientific Research and Planning Institute. The process control systems of these mills can increase the dimensional accuracy of strips, improve their profile, decrease electric power consumption, and increase the quality of production control by timely production of objective information concerning the operation of the mills. Subsystems of the process control systems include: automatic control of the electromechanical roll pressure device; automatic control of the main horizontal roll drive; automatic regulation of thickness and flatness of strips by speed asymmetry; automatic control of the movement of edgers; automatic control of roller conveyors; determination of optimal rolling programs and mill adjustment sequences. Operation of the process automatic control system is briefly described. The process control system is expected to yield the following quality characteristics: longitudinal thickness differences over 95% of the length of each strip ( $\pm 0.08$  mm for 6-12 mm thickness); variation in mean thickness over 95% of strips in a production run relative to the mean value  $\pm 0.12$  mm; decrease in transverse thickness difference by 0.015-0.02 mm; decrease in rolling force by 10 to 15%.

[59-6508]

/13046



CRITERIA FOR SELECTING PARAMETERS OF EXPLOSION WELDING PROCEDURES

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 9, Sep 85 pp 1-3

KUDINOV, V.M., corresponding member, UkSSR Academy of Sciences, State Committee of the USSR Council of Ministries for Science and Technology, and ZAKHARENKO, I.D., candidate of physico-mathematical sciences, Special Design Bureau of Hydroimpulse Technology, Siberian Department, USSR Academy of Sciences

[Abstract] Theoretical factors of the formation of explosion-welded joints have received little study. Experimental data show the decisive role of the strength characteristics of materials in explosion welding, but there is no generally accepted opinion on the processes determining the lower limit of the welding zone. The presence of oxides and impurities have been shown to affect the strength and plasticity of the seam. The nature of metal flow in a cumulative stream is related to the activation of contact surfaces and to dislocations. The upper limit of the welding zone is related to compressing stresses, hardening time and heat emissions, in a complex mechanism. Steel and copper were found to have good heat conductivity, close melting points, and low hardness. Other metal pairs, such as steel and lead, have widely differing melting points. Stabilization of explosion welding processes can be enhanced by substantially increasing the stability of the detonation process. Current ammonium nitrate explosives have not met these requirements. References 23: 18 Russian, 5 Western.  
[40-12131]

EFFECT OF OXIDE FILM THICKNESS ON POSITION OF LOWER LIMIT OF EXPLOSION  
WELDING ZONE

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 9, Sep 85 pp 4-5

ZAKHARENKO, I.D., candidate of physico-mathematical sciences, and  
KISELEV, V.V., engineer, Special Design Bureau fo Hydroimpulse Technology,  
Siberian Department, USSR Academy of Sciences

[Abstract] The article describes two series of experiments in welding plates by explosion welding with 6ZhV ammonite and mixtures of it with ammonium nitrate with the aim of establishing other than mechanical tests. Metallographic studies based on the lack of flaws and residual oxides in the seam were conducted. In the first series, round plates of St3 steel 1, 2, 3, and 5 mm in thickness and 50 mm in diameter covered with oxide films of equal thickness were welded, while in the second, 2 mm thick plates with varying oxide film thickness were welded. Results showed that the thickness of the oxide coating had a significant effect on the critical rate of contact, and the kinetic energy of the current per length unit was proportional to the weight of the target plate. Data from the second series of experiments made it possible to generate a formula for expressing the dependence of the critical rate of contact on the relative thickness of the oxide film on St3 steel and for the lower limits of successful seam formation in a given range of contact parameters. References 9: 7 Russian, 2 Western.

[40-12131]

EFFECT OF CONTACT SURFACE ROUGHNESS ON QUALITY OF ALUMINUM JOINTS DURING  
EXPLOSION WELDING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 9, Sep 85 pp 6-7

ZOTOV, M.I., engineer, DOBRUSHIN, L.D. and LOZOVSKAYA, A.V., candidates of technical sciences, SKLABINSKAYA, I.Ye. and TRUSH, A.I., engineers, Institute of Electric Welding imeni Ye.O. Paton

[Abstract] High-purity aluminum is in common use in the manufacture of equipment for producing and storing concentrated nitric acid. The equipment frequently undergoes corrosion failure at welds within 6-12 months, although the basic metal has a useful life of 5-10 years. The present article reports on studies of contact surface roughness and its impact on the chemical homogeneity of seams, which has been identified as a key factor in durability. Mechanical tests showed that initial seam durability approached that of the basic metal. For seams produced in the first series of tests, where roughness was limited to 0.8 mm variations, the melted zone

was 2.5 times that of the second series, where variations 2.5 mm in length were allowed. Dispersion of iron impurities was much greater in the melted zone than in the basic metal. Aluminum oxide in seams during explosion welding was the factor that determined chemical heterogeneity and consequent corrosion factors. Reduction of surface irregularities markedly improved corrosion resistance of the seams and useful life of the products.

References 9: all Russian.

[40-12131]

UDC 621.791.011:620.179.152.1

# REDUCTION OF RESIDUAL STRESS IN WELD SEAMS BY LINEAR CHARGES OF EXPLOSIVE SUBSTANCES

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 9, Sep 85 pp 8-9

KHOKHLOV, V.I., candidate of physico-mathematical sciences, POPOV, G.V., engineer, Scientific Production Association ANITIM, Barnaul; and PETRUSHKOV, V.G., doctor of technical sciences, Institute of Electrical Welding imeni Ye.O. Paton

[Abstract] Use of explosion energy to reduce residual stress is practically the only way to work seams of large-sized and complex structures, such as ships, hydroturbine blades, and the like. The present article reports on results of experiments and presents a phenomenological description of redistribution of residual stress after explosive processing, taking into consideration the elastic and dynamic properties of materials, the initial stress, and the size of the explosive charge. Samples of St3 steel and VT1-0 titanium were welded in CO<sub>2</sub> and argon, respectively, and then subjected to progressive explosive force with ammonite or hexoplastic charges. X-ray analysis then permitted construction of a stress-strain diagram. Use of a  $\sin^2\psi$ -method made it possible to chart the actual deviations of macro-stress distribution from the calculated model. Values were calculated in unwelded specimens, after welding alone and after explosion treatment at various charge sizes. Data made it possible to express the effects of progressive explosions processing in a formula, in which charge energy and thickness and crystalline structure of the metal are determined experimentally.

References 4: all Russian.

[40-12131]

## STRUCTURE OF WELDED JOINTS OF DIFFERING MATERIALS JOINED BY EXPLOSION WELDING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 9, Sep 85 pp 9-10

GRIVNYAKOVA, D. and TURNYA, M., candidates of technical sciences, Slovak Higher Technical School, Bratislava, CSSR

[Abstract] A basic condition for forming seams during explosion welding is proper placement of surfaces to assure interaction and bonding between atoms of the two surfaces. The process can be used to produce production components of various sizes made of differing materials. The present article reports on study of aluminum-structural carbon steel, aluminum-copper and copper-structural carbon steel bonds, whose mechanical properties after welding were assessed according to adhesion quality, formation and quantity of intermetallide phases, strain hardening, and mechanical blending of the materials. The surfaces to be welded were polished and cleaned thoroughly, then joined using "Semtex S 25" or "Semtex S 30" as the explosive, at a detonation rate of 2100-2300 m/sec. Metallographic studies showed that the intermetallides that formed at the interfaces increased somewhat as the heating temperature increased. Up to 100°C strength increased, then declined gradually as temperature was increased to 320°C. Throughout the temperature increase process, ductile failure occurred in the aluminum specimen. Adhesion accompanied by partial mechanical mixing took place in copper-steel joints. Minimization of cracking to prevent corrosion requires limitation of intermetallide formation. The quantity of intermetallides also has an adverse impact on viscosity and strength. References 6: 3 Russian, 3 Slovak.

[40-12131]

## DIFFUSION WELDING OF TITANIUM PROVIDING FOR MINIMAL ACCUMULATED DEFORMATION OF WELDED COMPONENTS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 9, Sep 85 pp 11-12

PESHKOV, V.V., RODIONOV, V.N., candidates of technical sciences, and NIKGOLOV, M.B., engineer

[Abstract] A factor preventing wide use of diffusion welding for manufacturing precision structures from titanium alloys is the difficulty of obtaining quality joints without significant accumulated deformation of welded components. The necessary compression used in the process contributes to deformation. The present article reports on study of the interaction between contact surfaces that have been polished before welding to minimize defect accumulation. Analysis of experimental data indicated that at  $P \leq 0.5$  MPa, joint formation and physical contact coincided. Microfractographic

analysis of defect surfaces showed that areas of initial contact were characterized by a minimal number of breakage ridges, while at 950°C other zones showed a scaly structure. At above 900°C there was a constant internal stress factor causing deformation of surfaces that had not yet been joined in the welding process. Mechanical tests showed that application of pressure led to greater joint strength at near-welding temperature than at 18-20°C. Differences in the strength characteristics of different technical procedures increased as welding temperatures increased. Physical contact with high reaction capacity was deemed necessary for optimum welds, with pressure at less than 0.5 MPa and temperature at 950°C. References 5: all Russian.  
[40-12131]

UDC 621.791.363

#### FEATURES OF SOLDERING COPPER TO 12Kh18N10T CORROSION-RESISTANT STEEL

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 9, Sep 85 pp 17-18

GRISHIN, V.L., candidate of technical sciences, and NOVIKOV, V.V., engineer

[Abstract] Various structures now in use call for joints between copper and 12Kh18N10T corrosion-resistant steel, which are best joined by soldering at 300-500°C. Analysis of solder indicated that silver-based solder with nickel (for high mechanical properties and corrosion resistance), manganese (for lower temperature soldering), silicon (for the same purpose and for better strength and self-fluxing), and phosphorus and boron for better flow and wetting of the steel, produced the best joints. The solder recommended is PSrMtsMN23, with a melting point of 850-910°C and soldering temperature of 930-960°C. Details of melting and soldering characteristics are summarized. Mechanical tests of the soldered seams, determination of transitional electrical resistances in the joints, and their long use indicated the high serviceability and reliability for the tested combination of copper and steel. References 4: all Russian.  
[40-12131]

## FAILURE RESISTANCE OF DEPOSITED ANTICORROSION LAYER DURING LOW-CYCLE FATIGUE

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 9, Sep 85 pp 18-20

LUKYANOV, V.F., candidate of technical sciences, VASILCHENKO, G.S., doctor of technical sciences, NAPRASNIKOV, V.V., candidate of technical sciences, GOLOVIN, V.P. and SKVORTSOV, V.V., engineers

[Abstract] Anticorrosion protection of the internal surfaces of atomic power plant equipment is achieved by coating with austenite steel, but various technological flaws can occur during this process, and subsequent plastic deformations are likely as a result of thermomechanical stresses. The present article reports on study of low-cycle fatigue factors using test disks of 15Kh2NMFA, 07Kh25N13, and 04Kh20N10G2 steels. The specimens were scored so that the concentrator surfaces were located in the melting zone of the base and the deposited metals. The modulus of elasticity for the base steel was  $2.1 \cdot 10^5$  MPa, while for the austenite coating it was  $1.95 \cdot 10^5$  MPa. Tests were performed at nominal stress values of 600 and 400 MPa. Crack formation was measured with a microscope. It was determined that a significant anisotropy in relation to the direction of deposit of austenite coating affected resistance to failure in the coating layer. Flaws across flow patterns were much more numerous than those that were longitudinal or at an angle to the flow of deposit. Structural variations in the deposited metal are considered to be the key to the failure patterns observed. Fatigue failure after tens of thousands of cycles along the entire groove, and appearance of the first macrocracking, did not signal damage throughout the entire length of the groove. References 3: all Russian. [40-12131]

## INFLUENCE OF NICKEL ON STRUCTURE AND PROPERTIES OF HIGH-SILICON CORROSION-RESISTANT SEAMS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 9, Sep 85 (manuscript received 24 Oct 84) pp 9-12

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[Abstract] A study is made of the influence of nickel on the structure and physical-chemical properties of high-silicon seam metal in 02Kh8N22S6 steel. Two series of welding wires were made, with 8 and with 17% Cr in the form of cast rods 3 mm in diameter. The materials were used with manual argon-arc

welding with a nonfusible EP794 steel electrode 8 mm thick. With 10-12% Ni in the welding wire, high silicon seams are produced with austenite-ferrite structure containing 3 to 8% ferrite, which assures good mechanical properties. Nickel at 10-60% has no influence on the corrosion resistance of the high-silicon seams. Welded joints in the steel tested have good mechanical properties and corrosion resistance only after austenitization. References 6: all Russian.  
[43-6508]

UDC 621.791.052-4:539.4.014

#### INFLUENCE OF WELDED SEAM SHAPE ON DISTRIBUTION OF STRESS WHEN THICK BUTT JOINTS ARE TESTED IN TENSION

Kiev AVTOMATICHESKAYA SVARKA in Russian No 9, Sep 85 (manuscript received 17 Oct 84) pp 25-28

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[Abstract] A study is made of the stress state of welded butt joints on the assumption that the thickness of the joints is relatively great, welding stresses are absent, the seams are symmetrical, and the body which was welded is homogeneously and uniformly stretched by a force applied far from the seam. Distribution of relative stresses are calculated and diagramed. The concentration coefficient and stress gradient at projections in the Neuber problem are less than in the convexities of butt joint welded seams. The concentration of stresses is determined by the dimensions of the convexity of the seam, the radius of transition from seam to base metal, as well as the slope of the beveled surface of the sheets joined by multiple-pass welding. Surface cracks through the middle of the convexity of the seam create less stress concentration than cracks on a half plane. References 9: 8 Russian, 1 Western.  
[43-6508]

UDC [621.791.46:678.5/.8:621.643.29].001.57

#### OPTIMIZATION OF HEATING PROCESS UPON BUTT WELDING OF PLASTIC PIPE WITH HEATED TOOL

Kiev AVTOMATICHESKAYA SVARKA in Russian No 9, Sep 85 (manuscript received 10 Oct 84) pp 42-44

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[Abstract] The purpose of this work was to demonstrate the possibility of decreasing the quantity of heat required for welding of plastic pipe by

optimizing the temperature of the heater and time of heating while conserving constant depth of melting of the pipe. The work was based on a model which assumed that heating of the pipe creates a distribution of temperature which determines the variation of temperature in the local pipe section as a function of the distance to the surface of the heater. Statistical processing of a file of data leads to the conclusion that good specimen strength is achieved if the value of the parameter  $f/x_1$  is between 0.5 and 0.9, where  $f$  is 10% of the wall thickness and  $x_1$  is computed by an equation presented in the article. The optimal temperature under these conditions is high, greater than the temperature of thermal destruction of the polymer, which is not the case in manufacture of pipe today. References 4: all Russian.  
[43-6508]

UDC 621.791.927.525.015:669.15.018.8

#### SPECIFICS OF FORMATION OF ROLLS BY SURFACING OF ANTICORROSION COATINGS UNDER FLUX WITH TWO ELECTRODE STRIPS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 9, Sep 85 (manuscript received 20 Jun 84, in final form 29 Dec 84) pp 56-59

STARCHENKO, Ye.G. and MASTENKO, V.Yu., candidates of technical sciences, Scientific-Production Association, Central Scientific Research Institute of Machine Building Technology

[Abstract] The purpose of this work was to determine the specifics of the change in the nature of the formation of rolls as a function of the mode of high productivity surfacing with two electrode strips, to suggest formulas for calculation of the major geometric parameters of a roll and to construct nomograms for selection of optimal conditions of the process in question, which assure good quality formation of the anticorrosion coating. The influence of surfacing mode parameters using two electrode strips on the specifics of the change in the geometry of rolls was studied using strips of Sv-07Kh25N13 alloy with 50 x 0.7 mm cross-section and OF-10 flux. Rolls 300 to 400 mm long were surfaced on plates of St3 steel 30-40 mm thick. The welding current varied from 800 to 1800 A, voltage 30-50 V, surfacing rate 8-40 m/hr, distance between strips 0-50 mm. Computer processing of the experimental results yielded mathematical models describing the change in the major geometric parameters of the rolls depending on the combined influence of the surfacing mode parameters. References 9: all Russian.  
[43-6508]



## INFLUENCE OF ELECTRODE STRIP SHAPE ON QUALITY OF STEEL SURFACED LAYER

Kiev AVTOMATICHESKAYA SVARKA in Russian No 9, Sep 85 (manuscript received 21 Mar 84; in final form 13 Feb 85) pp 60-62

LESHCHINSKIY, L.K., candidate of technical sciences, MATVIYENKO, V.N. and LAVRIK, V.P., engineers, Zhdanov Metallurgical Institute

[Abstract] To develop the optimal electrode profile, a study was made of the influence of electrode shape on the formation conditions and quality of a surfaced layer. Electrode strips used were flat, with beaded edges, profiled over the entire cross-section and compound, made of 08kp and 07Kh25N13 alloy 0.5-0.7 mm thick and 50-100 mm wide. Surfacing was performed under AN-60, An-348A, and OF-10 fluxes in direct current. Formation of the surfaced layer can be improved by changing the shape of the electrode. In order to surface rolls over 40-50 mm wide in a single pass, it is found best to use strips profiled over their entire surface or compound cross-section electrodes. This decreases the number of defects in the surfaced layer. References 7: 5 Russian, 2 Japanese.  
[43-6508]

## SPOT FRICTION WELDING OF THIN SHEET METALS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 9, Sep 85 (manuscript received 25 Nov 85; in final form 4 May 85) pp 71-73

POLINOVSKIY, L.A., candidate of technical sciences, VEKSHENKOV, I.A. and CHIPUNOV, V.I., engineers, Novosibirsk Institute of Railroad Transport Engineering

[Abstract] The purpose of this work was to determine the possibility of producing high quality spot-welded joints with a thickness of welded sheet over 0.5 mm. A simple installation was developed for the studies with one-sided heating of the metal with a rotating die. Operation of the device is described. The welded parts are heated by friction between the spinning die and one of the parts to be welded. The loading rate can be varied. Fifty welded joints with the same thickness and several with varying thickness were produced in the studies, and all were shear strength tested. It was found that spot welding by friction heating can be used to produce satisfactory quality welds, equal in static strength to joints welded by contact methods. The method can in some cases replace the method of contact spot welding. References 4: 3 Russian, 1 Western.  
[43-6508]

/13046

## EXTRACTIVE METALLURGY AND MINING

### SITUATION AT KIRGIZ GOLD ORE COMBINE OUTLINED

Frunze SOVETSKAYA KIRGIZIYA in Russian 7 Sep 85 p 2

[Article by SOVETSKAYA KIRGIZIYA special correspondent V. Zyryanov, Naryn Oblast: "1. The Price of Miscalculations Is Great: How the Situation at the Construction Site of the Kirgiz Gold Ore Combine Is Turning out"]

[Text] The fate of this project worries many today. This construction project was advanced into the category of directive projects by decisions of the 26th CPSU Party Congress. Therefore, that attention which is being paid to it by the Central Committee of the Kirgiz Communist Party, the republic's government and local party and economic bodies is understandable. Having spent some time here, one senses how many steps were taken on their part to influence the general course of construction in a fundamental manner and to insure the over-all resolution of financial, engineering, organizational and transportation problems and the concentration of the forces of construction sub-units. But was this all done so that the republic's builders could report with honor at year's end: "The Party's assignment was fulfilled on time!"

Up to the Fall -- We Consider...

To start with, let us see what the future combine has in its assets. Of the total volume of capital investments, a total of 68.5 percent has been used in production construction. Funds used in non-production construction amount to 31.5 percent.

Since the moment of the pioneering entry into the area, a base for the construction industry has been established here having a capacity of 50,000 cubic meters of reinforced concrete and ready-mix concrete per year. Housing with a total area of 12,100 square meters, a kindergarten and a dining hall have been built. A new road has been built, and regular air and bus service with Naryn and Frunze have been organized.

For better supply of food products, a slaughtering point and a milk receiving point have been built in the regional center at the initiative of the Naryn party obkom.

Now it is already without question that with the end of construction for the combine the Toguz-Torousskiy Rayon will get broad new prospects for its development, that in the near future the necessary elements of the social-domestic infrastructure will soon appear here. Without fail, the new, modern settlement must join the natural environment harmoniously. People will be able to live and work, having high quality apartments and all the blessings of everyday social and cultural life.

Nevertheless, I think, the situation here will not cause optimistic illusions, even in a person who is not too dedicated to construction matters. The tenacious eye of the business executive will start to count the flaws and blemishes all the more. And the more carefully, in the more detail he starts to do this, the more depressing the picture which will present itself to him, the more relentlessly the question will haunt him: "is there enough time to patch up all the holes and flaws, to submit the first section of the gold ore combine by the set deadline?"

Let us begin at the "head" of the technological chain, the mine. The total readiness of the projects of the industrial site is only 26 percent in all. Of 22 projects in the start-up complex, construction is under way at present at only 15. Work has not begun on the heating system, the petroleum products warehouse and others. The earthen roadbed along the ore and rock carrier roads is only 70 percent completed, and the highway between the mine and the concentration plant is less than half paved. Because the road construction is going so slowly, development of the entire field may be delayed for a long time.

Let us take an important sector of the ore and rock carrier road No. 1, leading to an elevation of 2700 meters above sea level. Here five-cubic-meter excavators and complex drilling equipment should make their way and begin stripping operations. However, the route is not ready, and the road builders are at fault; deadlines for the start of preparatory mining operations have been broken.

The "heart" of the combine is the enrichment plant. Plans for its full readiness are not fated to be accomplished as yet. Here, work is under way on only 36 of 47 projects of the start-up complex, and the quality of the projects leaves us to desire better. The picture of the foundations under equipment in the main building cries out. It may be said that these are not foundations, but monuments to stupid bungling. Total waste. And it took 420 cubic meters of concrete to prepare them!

Moreover, work on the transport galleries and electric systems was just started in May of this year. The water supply wells were completed with deviations from the design as well.

In a word, the situation which has come to exist on the projects of the start-up complex is very serious. In construction headquarters they consider that for normal start-up it is necessary to submit 15 projects monthly, and such a tempo is unknown here.

Yes, it is difficult to compensate for that which was neglected, to complete everything by the planned deadline. Construction is in deep time trouble. It may be that this is no time to stir up the past, but time to give their due to those who poked sticks in the spokes and bothered those who came first in doing what they had to do.

#### Huts for the Landing

Much was omitted here even in the preliminary period [period obustroystva ]. And if each of the sisters were to be given ear-rings today, the first ones, and by no means the gold ones, must be awarded to workers of the republic's Minstroy [Ministry of Construction]. It was their former deputy minister E. Bakeyev who, not hesitating for an instant, gave birth to a remarkable conception: "We will build a combine, and we will leave Toguz-Toro. And one cannot take housing with them, so why build it." Did he think that the combine's engineering personnel would be put up on cots in the factory's galleries and the builders would get by somehow in huts and dugouts?

The fruits of such a relationship to business soon makes itself known. Having arrived here, people went back to where they came from without hesitation. Who would want to knock about, languishing for long periods when they are far away from home? Even if they were promising wonders, they would find no takers.

Here is an unpleasant statistic about the immense turnover in cadres just at PMK-264. In 1981 the replacement rate there was 112 percent, in 1982, it was 61 percent, 167 percent in 1983, 80 percent in 1984 and 96 percent this year.

In the republic's Minstroy they haven't moved a finger for a long time to warm and shelter the first comers. You might think that they had no money, but they had. Mintsvetmet [Ministry of Non-ferrous Metallurgy] allotted them 3.5 million rubles for housing construction. But Minstroy didn't build a single building with this money. It is difficult to call this fact 'negative.' It is flagrant! Because of this nearsighted policy, for a long time, a construction worker had to make do with about 2 square meters living space on the average. At night, every dormitory was turned into a flop-house.

It seemed that the problem was just hanging in mid-air. And then an air bridge came to the rescue. The shift method got the construction site out of trouble. The isolation, lack of roads and many of the other blessings of civilization (so we will call them) are not to the liking of many. People were taken out from under their own roof without any particular desire. And it was only the shift method that removed the seriousness of the problem. It was the specific mobile nature of labor, if you will, that became the cause for a fundamental change at the construction site. Qualified cadres came here. Labor productivity began to rise.

To compensate somewhat for the shortage in living space, the UKS [Capital Construction Administration] of the Naryn Oblispolkom started to do what a powerful organization, the Minstroy, could not succeed in doing. It put 5,200 square meters of living space in use, no small figure. This aid to the combine's construction workers was rendered at the expense of the oblast's workers.

### From Sleep to Bestirring

The situation at the construction site may thus be characterized this year. Beginning in the second quarter, matters here moved more quickly. Thus, during the current year, construction and installation operations were completed in an amount of 10.868 million rubles, or 6.253 million rubles more than for the same period last year. In June-July alone, construction organizations of Minstroy completed construction and installation work in an amount of 4.323 million rubles.

Fixed capital in the amount of 4.210 million rubles was put in operation. This included a machinery and repair shop, a truck garage, a workers supply administration base, a consumer services combine, and a bath. Living quarters are rapidly being built. Construction and installation operations have been completed here since the first of the year in the amount of 8.412 million rubles. This is 120 percent of the plan.

But there is still no cause for beating the drums yet. When confidence in one's own strength appeared in the people, alarm signals started to flare up above the construction conveyor. And it is becoming more and more difficult to extinguish them.

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CSO: 1842/55

## WORK IN SIBERIAN GOLD FIELD EXAMINED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 19 Oct 85 p 1

[Article by N. Ilinskaya, special correspondent for SOTSIALISTICHESKAYA INDUSTRIYA, Bodaybo, Irkutsk Oblast: "Here They Dig Gold in the Mountains"]

[Text] The car descended toward the dredge along a narrow road among the man-made "ridges," made from gold bearing rock taken from the river bottom and processed by the dredge. Across a bridge going over to the bank we go out onto a deck which is shaking from the operation of powerful pumps. They provide 18 cubic meters of water per second at a pressure of 6 atmospheres to wash the gold bearing rock. In essence, a dredge is a floating factory joining two processes -- recovery of gold and its concentration. The production is energy-intensive: tens of thousands of kilowatt-hours per day are required.

The "captain's bridge" of the floating factory is the so-called dredge room. Aleksandr Viktorovich Grachev is here at the control panel now.

He is introduced by Vladimir Danilovich Makarov, director of the Lenzoloto Association as "one of our best dredge operators. He began his career 15 years ago as a shop hand. He completed mining school right here in Bodaybo. And he has been a dredge operator for 5 years."

From the dredge room, elevated 12 meters above the deck, there is a fine panoramic vista. But the dredge operator has no time for the beauties of nature. His attention is fixed on the washhole of the face, on the chain of scoop buckets going into the water. Each of the 115 scoop buckets brings gold bearing rock up from a depth of 30 meters. Instruments on the control panel set the tension on the chain. Now it has reached the limit. A. Grachev, having pressed on a lever, puts it slowly into reverse. The skill of the dredge operator is a guarantee of the safe operation of equipment. At the wash site, each hour is precious. And on this dredge, each minute registered.

"We have to finish our work here completely by the end of the season," Grachev tells us. "Next summer we are scheduled to open navigation for gold in a new field."

"The new site is not far away, within 3 kilometers," N. Tretyakov, deputy chief engineer of the association enters the conversation. "But it usually takes

more than 2 years for dismantling the machinery and setting it up in the new place. In order to save time, we decided to deliver the dredge under its own power."

"But how? A dredge weighs thousands of tons."

"Do you see over there, where the excavators are working? They are digging a canal 80 meters wide and 30 meters deep. Two dams of 19 and 10 meters will form a lock, with the aid of which the dredge will get over the watershed. And launches will be brought up to its work place to tow it. The costs will be repaid with interest by the savings in time. The dredge will be able to start washing the sands in 6-8 months..."

"The technical innovations which facilitate labor and increase productivity are now the property of all the placers," says Yuriy Ilich Butakov, first secretary of the party's Bodaybo gorkom. "But the search for reserves produces much. On the best dredges, for example, preventive maintenance is performed during maneuvers, when the floating factory is being moved to a new face. For this reason, it is possible to continue washing the sands during those days set aside for planned repairs. The collective contract is also being more widely used, focusing people on efficient work. But most important, of course, is the people themselves, their high professionalism, responsibility and pride in their work."

Among the gold field workers there is not a man who would not have two or three related specialties. Particularly if his work is connected with machinery, for which there is a special careful regard here. Each breakdown means idle time. And time for the miners is worth its weight in gold, in the fullest sense of the word.

They do not just use dredges in the Lenzoloto association. Excavators begin preparation of the sites. They dig through the permafrost layer down to the gold bearing zone. Powerful hydraulic dredges and enrichment installations are used in open mining of placer deposits, and deep-lying gold is recovered using shaft mining.

Nevertheless, the pride of Lenzoloto is the only dredge in the country which processes rock from a depth of 60 meters. It can be compared with an ocean liner in every way. Each of its 170 scoop buckets weighs 3 tons. Even huge boulders up to 5 meters in diameter hold no fear for it. This multi-storied floating factory operates with such productiveness that it takes the place of 12,000 workers. The Irkutsk Heavy Machine Building Plant manufactured the dredge.

"Modern enrichment technology which permits the maximum recovery of grains of gold posed the question of the secondary working of certain old holes," says the association's director. "Some of them were developed 100 years ago and more ago, when the prospector's arsenal consisted of a pick axe and washing pan. Specialists of the Irkutskgeologiya Association reevaluated resources and found that it spoke in favor of secondary gold extraction...."

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ORDER OF SOCIALIST LABOR DECREED FOR GOLD MINING ACHIEVEMENTS

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 25 Oct 85 p 2

[Order of the Presidium of the USSR Supreme Soviet, signed by A. Gromyko, Chairman of the Presidium of the USSR Supreme Soviet and T. Menteshashvili, Secretary of the Presidium of the USSR Supreme Soviet, The Kremlin, Moscow, 24 October 1985]

[Text] On conferring the title of Hero of Socialist Labor on V.G. Grechko, leader of a combined brigade at the Polyarninskiy Mining and Enrichment Combine of the North-Eastern Gold Mining Production Association (Severovostokzoloto)

For the great contribution toward increasing the efficiency of mining production, for the achievement of high indicators in socialist competition, for fulfilling the plan quotas of the 11th Five-Year Plan for gold mining ahead of schedule and for the heroism in labor which he has demonstrated, Comrade Grechko, Vladimir Grigoryevich, leader of a combined brigade at the Polyarninskiy Mining and Enrichment Combine of the North-Eastern Gold Mining Production Association (Severovostokzoloto) of the USSR Ministry of Nonferrous Metallurgy is awarded the title of Hero of Socialist Labor, with the conferral of the Order of Lenin and the gold "Hammer and Sickle" medal.

MEDALS AWARDED BY DECREE

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 25 Oct 85 p 2

[Article: "Within the Presidium of the USSR Supreme Soviet"]

[Text] For great success in increasing the efficiency of mining production, for the achievement of high indicators in socialist competition and for fulfilling plan quotas of the 11th Five-Year Plan for gold mining ahead of schedule, the Presidium of the USSR Supreme Soviet, in an Order dated 24 October 1985, awarded orders and medals of the USSR to the most distinguished members of a combined brigade at the Polyarninskiy Mining and Enrichment Combine of the North-Eastern Gold Mining Production Association (Severovostokzoloto) of the USSR Ministry of Nonferrous Metallurgy, headed by Com. Grechko, V. G.



One person was awarded the Red Banner of Labor, 4 the "Badge of Honor," 5 the 3d Degree Order of the Glory of Labor, 2 the medal "For Valor in Labor" and 4 the medal "For Distinction in Labor."

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CSO: 1842/55

## LACK OF RESPONSIBILITY IN RAW MATERIALS WASTE MANAGEMENT SCORED

Moscow IZVESTIYA in Russian 11 Nov 85 p 2

[Article by M. Sergeyev, Director, Institute of Economics, Ural Scientific Center, USSR Academy of Sciences, Corresponding Member of the USSR Academy of Sciences, Sverdlovsk: "Resources Do Not Belong to Someone Else"]

[Text] In the draft of the basic directions for our economic and social development, the main ways for intensification of the economy are indicated. These are acceleration of scientific and technical progress, reconstruction, technical re-equipment of fixed production capital, and efficient use of available resources.

The latter is of particular significance for the Urals - the largest mining base of the country. It is known that the mineral wealth of the Urals is fabulous. Almost the entire periodic table is represented. Something else is also known: one-fourth of the raw materials used to feed the region's enterprises are brought in from other areas of the country. Is this not a paradox?

The fact is that, since development of the ore riches of the Urals was first undertaken, a substantial portion of them have gone into wastes. A typical example is the Vysokogorskiy mine, which is under the jurisdiction of the USSR Minchermet [Ministry of Ferrous Metallurgy]. Here, in addition to iron, there is much copper. It could be extracted along with the iron cheaply and simply. However, the Minchermet insists that copper is a raw material that is not within its purview. Meanwhile, only iron is extracted from the ores, and "their" (meaning Ministry of Nonferrous Metallurgy) copper is hauled to the dumps. The situation is similar at the Severouralsk Bauxite Mine. In this case, the Mintsvetmet [Ministry of Nonferrous Metallurgy] mines along with "its own" bauxites millions of tons of iron ore, which it considers as "someone else's," and sends it directly to the dumps.

The division into "ours" and "someone else's" in these matters is fundamentally incorrect and detrimental to the economy. The iron ores of the Urals are 90 percent complex in nature. The copper ores consist of more than 20 elements, and the bauxites of 45. However, only iron and vanadium are extracted from the iron ores; a good half of the most valuable components remain after processing of copper. Only a single element is recovered from the bauxites.

This is why the need has become acute to install in the Ural mines and plants the latest equipment and technology that is responsive to the tasks associated with the complex processing of raw material. Scientists have accomplished much in this regard. For the first time in world practice, in the Urals the processing of the titanium-magnetite Kachkanarskiy ores, which have a very low iron content (16 percent) has been mastered. Their industrial utilization was made profitable thanks to the associated extraction of a valuable alloying element - vanadium. Scientists of the Institute of Metallurgy, Ural Science Center, USSR Academy of Sciences, have proposed a method of smelting copper-zinc concentrates. Blister copper is produced in one operation; the degree of sublimation of zinc, lead, cadmium, and rare elements is raised; 99 percent of the sulfur is extracted; and the separated slags are suitable for further processing. The Uralmekhanobr institute has found it possible to utilize sulfide-magnetite ores in an integrated manner. Numerous examples can be cited, but, with the exception of the Kachkanarskiy, not a single process devised by the scientists has been put into practice.

It would appear that everyone would agree that mountains of tailings from metallurgical production and of unprocessed raw material represent poor management. In the special-purpose integrated national economic program "Intensification of the Industrial Production of the Urals" there is provision for resolving of the problem of the complex processing of raw material without regard to "departmental affiliation," and the question is raised of the need for organizing in the Urals a mining complex which would be unified in territorial and production aspects.

Our economics institute has been confirmed as the head organization for developing the methods for the designing and operation of such complexes. We are of the opinion that the vicious bureaucratic circle can and must be broken. The draft of the Basic Directions, which clearly advances the concept of the integrated development of the country's economy, aims us at this.

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CSO: 1842/73

## MAJOR METALLURGICAL CONSTRUCTION PROJECT WORSENS ALREADY ACUTE WATER SHORTAGE

Moscow IZVESTIYA in Russian 15 Nov 85 p 3

[Article by S. Troyan, IZVESTIYA correspondent, Zaporozhye Oblast, Ukraine:  
"Cheap is Dear in the Long Run"]

[Text] Sensing that the conversation was coming to an end, the interlocutor remarked heatedly, "I thought that you came here to help our construction project to get out of a debacle. The first start-up complex, you see, was to go into operation last year... Maybe the builders need some urging, since the country needs manganese. But you seem to be sidetracked..."

"The country needs manganese!" I heard this weighty statement repeated a number of times with the additional phrase, "but some comrades are obstacles in the way of things." That is what A. Gramatunov, Director of the Tavricheskiy Mining and Enrichment Combine, which is under construction, said.

To understand the meaning of the remark, a word of explanation is in order.

From time immemorial, the rich black soil around the Dnieper has produced bountiful harvests of grain, sunflower, vegetables, melon, and fodder crops and fruits. Year after year, the same shores also produce millions of tons of pig iron and steel and billions of kilowatt-hours of electric power. On top of that, in the post-war years, geologists found substantial deposits of raw materials for open-hearth and blast furnaces. A mine which spread out on the shore of the Kakhovka Reservoir in 1967 furnished the first carload of ore. Only four years later, the first million tons was produced. Subsequently, the yield, naturally, increased in a steady manner.

The settlement Dneprorudnoye, which was classified as a town in 1970, grew near the Belozerskiy deposit. There are several thousand inhabitants there now. Everywhere, there are gardens; not far away the waves of the Slavutich play - how can we not envy the people who live there? Persons new in the area who do not know of the major local problem consider that every Dneprorudnoye resident is very lucky. However, paradoxical as it may seem, people living near the largest Ukrainian river cannot always slake their thirst. And, you see, the North Crimea, Dnieper-Krivbass, and Dnieper-Donbass canals have been built. It is fair to say that the residents can bathe three times a day, but as far as drinking the water is concerned...

Only the oblast center and small town of Volnyansk have sufficient Dnieper drinking water. Residents of the remaining part of Zaporozhye Oblast drink water supplied by artesian wells which, unfortunately, tend to run dry. No one has come up with an accurate figure of how many populated places (especially rural locations) there are where the inhabitants are forced to dig holes in their yards, line them with concrete, and bring in water in barrels and tank trucks to fill the pools. The situation is especially critical in Novonikolayevskiy Rayon. Area villages have lost 7,000 people - every fourth inhabitant - in less than 20 years. Who wants to purchase water continually by the bucket! But as soon as people heard the rumor, "They have started to lay a pipeline from the Dneiper," migration out came to a halt.

It is true that the villages and settlements which have "run dry" can hardly be restored to a viable condition. While the latest reference book of the administrative and territorial division of the oblast was being prepared for printing, the "Index of Places Removed from the Register Due to Departure of Inhabitants" was corrected by hand as a result of the dropping of Novobelikov, Klyuchi, Kislitskiy, and Stasy. I do not venture to say that the shortage of water was the only cause, but its lack was one of the factors accounting for the sad entry "Removed from the Register" opposite some populated places. If very decisive steps are not taken, in the near future the list of villages which have disappeared may increase substantially.

Now, let us return to Dneprorudnoye. There is nothing more permanent than that which is temporary. This old and trite saying involuntarily comes to mind when one thinks of the fate of a town which only a decade and a half ago was described by someone as a "town of a hundred wells." Yes, one hundred wells did indeed supply water here. Now, not counting a small reserve, it is provided by 20 wells. In the remaining wells, the water has simply disappeared. For this reason, it is made available on a schedule - three times a day. In the summer months, people living on the fourth and fifth floors generally have no water for all practical purposes.

Did they in the UkSSR Minchermet [Ministry of Ferrous Metallurgy] in the sixties, when construction of the combine was about to be undertaken, know what could happen in several years? They could not help but know, they should have known, once they offered to become proprietors of this corner of Zaporozhye. What did they have in mind in the department when they asked the local authorities to permit use of the wells as a temporary water supply for the industrial and residential facilities? They thought at the time to first erect the basic production facilities, then initiate efforts to obtain "reliable water." The first was done, the second was not attempted. Instead of a fundamental solution, they proposed cheap alternatives.

"We are not so rich as to buy cheap things" - he who forgets this wise truism pays twice and three times as much. In pursuing an illusory immediate advantage, we completely forget about future adverse consequences. The result is that we think of how we can obtain underground treasures at low cost while we lose that which lies on the surface. As early as the middle of seventies, there were voices in the appropriate services and departments

pointing out the advisability of laying a multi-user (Grupповой) water main and of providing water not only to the iron ore combine and Dneprorudnoye but also to other towns, villages, and settlements. It was proposed to construct this project by pooling resources. Then, the republic Minchermet refused to take on the role of general customer and to combine the shares of the enterprises of neighboring towns and of "unrelated" departments - the Mintyazhmash [Ministry of Heavy and Transport Machine Building], Minavtoprom [Ministry of the Automotive Industry], Minzhivmash [Ministry of Machine Building for Animal Husbandry and Fodder Production], and the Zaporozhye obispolkom. A 27 September 1977 order of the UkSSR Council of Ministers dealing with this question has hung in mid-air. So, they continued to live on the basis...of a temporary arrangement. They slapped something together for their own needs, and everything else can go to hell. Let others also find temporary solutions, if necessary.

Water is life itself. Everyone runs away from a place where there is none.

Was a lesson learned from the bitter experience of Dneprorudnoye? Tens of kilometers away and close to the Moscow-Simferopol route, near the village of Sukhoivanovskoye, a new mining and concentration combine is now growing. It has already been given a name - the Tavricheskiy combine. Manganese ore will be mined here. The same ore that is "so needed by the country." Geologists found this treasure near a ravine which was said to be "dry" some time ago. It is not too difficult to guess why. It was precisely in such a place that it was decided, after much controversy, to establish not only the enterprise but also a town. After considering the importance of the project, the local authorities permitted the mining and concentration combine being built to take water from wells temporarily. Temporarily! This year, or at least toward the end of the year, this place, Sukhoivanovskoye, was to start receiving Dnieper water pumped through an 80-km water main from Blagoveshchenka. From the same town which at one time was to be the source of water for Dneprorudnoye. Alas! - there will be no water. And not only in the near future. If the present attitude does not change, of course.

The functions of general customer for the construction of the water main have been assigned to the Tavricheskiy Mining and Concentration Combine. This is fair, since its share is more than two times greater than that of the remaining participants - the Zaporozhye obispolkom, Mintyazhmash, Minavtoprom, and the Minzhivmash - combined. What are the efforts of the managements of the combine under construction and the UkSSR Minchermet directed at? Director A. Gramatunov's thinking is still dominated by ore production. At any price. For today only. Even if for want of water the flow of ore would cease tomorrow.

"Isn't this kind of management risky?"

"We know that not far from Sukhoivanovskoye, at the village of Lobovoye, there is water, and we can drill wells there," said Anatoliy Romanovich, obviously searching for the same temporary sources, "help us obtain permission to take water from there."

"Are these not also half measures," I said, trying to object.

"Measures... half measures... You understand that the country needs manganese!"

Nine-story buildings have been erected on the site of the future miner's town. They already are without water some of the time. The truth is as obvious as can be: for those that will be put into operation in the near future, there will be no water. To say nothing of the fact that the water presently supplied by wells contains large amounts of mineral impurities and "clogs heating systems and inside water pipes and causes pumps and boilers to fail." I was given this bit of information: Due to the water quality, the heating systems in Sukhoivanovskoye can last only 4 years, whereas the normal lifetime is 25 years. The cost of replacing the inside water pipes in each building comes to 20,000. This is only one example, and not the most impressive one at that, illustrating what a lag in "logistics" leads to and when rapid reporting is pursued.

"We will be able to set the first phase of the Tavricheskiy Combine into operation after a fashion," said S. Ulyanich, Chief of the Capital Construction Department of the Ukrruda [expansion unknown] association, "but no one can say for sure how everything will turn out there. If the water line were only ours, everything would be much simpler. It would be smaller, it's true, but then we could bungle it fast."

Here it is - the departmental approach, which makes us pay dearly. How many funds are wasted because of division of interests into "ours" and "theirs."

Some time ago, someone in the UkSSR Minchermet dropped the remark, "In Zaporozhye they want us to not only build the Tavricheskiy Mining and Concentration Combine but also water the entire oblast at the same time." Even if there were no Dneprorudnoye with its "short rations" and no Sukhoivanovskoye, the prime consideration would still be the need for Dnieper water. As if miners would have no need for the grain, vegetables, meat, and milk produced by the farmers in neighboring areas.

Meanwhile, of 40 million rubles allotted to construction of the water main, less than 3 million have been used. The latest reminder made by the Zaporozhye Oblast Soviet ispolkom to the management of the mining and concentration combine under construction and to the UkSSR Minchermet about the need to accelerate construction of the "first priority item" gave rise to an explosively hostile written response. What did the leaders of the enterprise being built write in reply? They complained to their republic department that unjustified demands are being made of them. They claimed with indignation that there is no technical documentation for the water line (in reality the necessary part of the documentation has been available for some time). Finally, they stated that the general contractor - the Zaporozhrudstroy [expansion unknown] trust - has not used the capital investments. The UkSSR Minchermet and the Combine consider their mission completed after sending off a pack of justifications and explanations in response to the oblispolkom's latest letter.

It is too bad that the oblispolkom, which reviewed the construction progress of the Tavricheskiy combine three times in the recent past and passed very good resolutions in this regard, is not as insistent as it should be in having its demands met. It does not deserve reproach, of course. However, it should be said in all fairness that it is not an easy task for local authorities to deal with a republic ministry.

Everyone knows that construction of the water main and of structures related to social and everyday needs is lagging behind industrial construction. One can agree that there are too many general contracting and subcontracting organizations for the important construction project and it would be much better to create a special trust in Sukhoivanovskoye, etc. However, who is to resolve these problems if not the departments that are charged with building the water main? Is it not the customer that is given the right to determine the importance and priority of construction jobs?

"The country needs manganese" is a phrase which, in the opinion of the departments, justifies everything. K. Kotov, republic Ferrous Metallurgy Deputy Minister, wrote the following in his own hand on one of the documents related to the problem: "The comrades from Zaporozhye do not understand that it is important to provide the country with manganese." They do understand, Konstantin Ivanovich, which is why they want to set the matter on a firm footing. But you also should understand that only people can provide the country with manganese. However, in the meanwhile, they are deliberating as to whether it is worthwhile to hurry to the beautiful buildings of Sukhoivanovskoye, which may be left without water tomorrow if not today. You see, even the mining and concentration combine director and certain chief specialists dare not risk moving their families there, preferring instead to retain their Zaporozhye residence permit.

13005/13046  
CSO: 1842/73



UDC 669.63

DEVELOPMENT AND INTRODUCTION OF HIGHLY EFFECTIVE EQUIPMENT AND TECHNOLOGY FOR  
COMBINED PROCESSING OF TIN-CONTAINING RAW MATERIALS

Moscow TSVETNYYE METALLY in Russian No 10, Oct 85 pp 19-21

CHUMAK, Z.V.

[Abstract] Theoretical studies of centrifugal filtration of tin to remove solid impurity crystals with limited solubility, as well as vacuum distillation to remove volatile impurities, were undertaken in order to develop a technology for purification of tin. The new principle of centrifugal filtration is the basis of several designs of purification apparatus. Centrifugal filtration has been introduced at the Novosibirsk tin combine to remove iron and arsenic and at Ryaztsvetmet Plant to remove copper from tin-lead melts. A process of vacuum refining of tin has been introduced at Novosibirsk tin combine as well. Mastery of the new continuous processes for purification of tin has allowed elimination of leaching of concentrates to remove lead, bismuth, iron, tungsten; and the use of lower grade tin-containing raw materials.  
[59-6508]

UDC 622.7-52

USE OF THE ELEKTRONIKA-60 MICROCOMPUTER IN THE AUTOMATIC PROCESS CONTROL  
SYSTEM AT UCHALY BENEFICIATION PLANT

Moscow TSVETNYYE METALLY in Russian No 10, Oct 85 pp 25-28

ABDRAKHMANOV, I.A., ZABELIN, V.L., SAZANOV, N.I., TOPOROV, V.I. and  
YAKUBOVICH, V.I.

[Abstract] An automatic process control system was introduced in December of 1984 at the Uchaly Beneficiation Plant for controlling the process of grinding and flotation in one section. The automated system utilizes two computer systems based on Elektronika-60 microcomputers and equipment for communicating with the controlled system developed at Soyuztsvetmetavtomatika Scientific-Production Association. One computer system is used for monitoring, the other for direct control. A block diagram of the system is presented, illustrating the connections among the computers, controllers, sensors, and

process equipment. The system has achieved a savings of 10% of the xanthate and flotation reagent, a decrease in copper content in tailings of 0.010%, and zinc -- 0.15%. After the automated section of the plant is fully equipped with slurry, air and water flow sensors and all of the stabilization systems are under computer control, including the copper and zinc flotation systems, a full analysis of the technical and economic effectiveness of the process control system will be undertaken.  
[59-6508]

UDC 669.536.22

#### STUDY OF AUTOCLAVE SINGLE-STAGE HIGH-TEMPERATURE LEACHING OF ZINC CONCENTRATES

Moscow TSVETNYYE METALLY in Russian No 10, Oct 85 pp 39-42

NABOYCHENKO, S.S. and BOLATBAYEV, K.N.

[Abstract] Results are presented from studies involving autoclave high-temperature leaching of zinc concentrates using sulfite-cellulose alkali as surfactant. Conditions are selected to provide good extraction of zinc and acceptable selectivity of leaching with respect to iron. The concentrate used in the studies contained, in percent: 47.8 Zn, 9.6 Fe, 0.8 Cu, 33.0 S. The model electrolyte contained 162 g/dm<sup>3</sup> H<sub>2</sub>SO<sub>4</sub>, 42 g/dm<sup>3</sup> Zn. The influence of initial acidity and time on consumption of surfactant was determined, the consumption decreasing with increasing H<sub>2</sub>SO<sub>4</sub> concentration. High-temperature single-stage leaching of the zinc concentrate had several advantages over low-temperature leaching: leaching time was decreased by a factor of 2-2.5 to 2-2.5 hr; the acid and iron content in the solutions obtained was decreased by a factor of 2; acid consumption was decreased without influencing zinc extraction; selectivity was improved; temperature control was stabilized and simplified, and the heat of exothermic reactions was utilized. References 4: 3 Russian, 1 Western.  
[59-6508]

UDC 622.765.06

#### MECHANISM OF ACTION OF COMBINATION OF THIONOCARBONATES WITH XANTHATES IN FLOTATION OF COPPER-MOLYBDENUM PYRITE-CONTAINING ORES

Moscow TSVETNYYE METALLY in Russian No 10, Oct 85 pp 99-102

NEDOSEKINA, T.V., GLEMBOTSKIY, A.V., BEKHTLE, G.A. and NOVGORODOVA, E.Z.

[Abstract] O-isopropyl-N-methylthionocarbonate (ITK), an analog of Z-200, is now being produced in the USSR. Its use is delayed by the lack of effective techniques for flotation using ITK. Studies have shown that the introduction

of butyl xanthate sharply increases the extraction of pyrite when ITK is present. This synergistic effect is particularly favorable with small consumption of xanthate and when the pyrite first contacts the ITK. Successive contact of the minerals, first with ITK, then with xanthate, achieves extraction of chalcopyrite 3 to 5% greater than the extraction with either reagent alone, increasing extraction of pyrite to 95%. The reason for this synergistic effect is an increase in the strength of adsorption of ITK on the surface of the mineral in the presence of xanthate.  
References 3: all Russian.  
[59-6508]

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CSO: 1842/000

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